

Knights
Water
Wheels

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CATALOGUE
OF
WATER WHEELS
AND
HYDRAULIC APPLIANCES

MANUFACTURED BY

KNIGHT & CO.

1886

SUTTER CREEK, AMADOR COUNTY, CAL., U. S. A.

EDWARD A. RIX & CO.

Sole Agents,

18 AND 20 FREMONT STREET,

SAN FRANCISCO, CAL.

October 1, 1886.



THE KNIGHT WATER WHEEL.

About 20 years ago Mr. KNIGHT, in common with others, made water wheels entirely out of wood, the buckets were shaped like Saw Teeth, and wooden flanges covered the sides of the buckets to confine the water: a round nozzle was used and the general results were considered at that time highly satisfactory.

The next step about two years later was to make a wooden wheel with iron buckets, giving them a curve and discharging the water toward the centre of the wheel, still using, however, the round nozzle.

Two years later than this a man named COLEMAN patented a wheel which had a bucket shaped very much like the present PELTON Bucket, the stream splitting and curving off to each side. He, for lack of means, we understand, did nothing with it.

After two or three years more had passed, Mr. KNIGHT made an improvement by using a curved iron bucket and having the discharge toward the centre and to one side, much the same as the present COLLINS' wheel, still using the round nozzle.

After continued experiments with the round nozzle he found it did not fill the general requirements; he could not cover enough bucket space along the periphery of the wheel, without covering an equal space in the width of the bucket, by increasing the diameter of the round nozzle.

This induced him to try an Elliptical or Oblong nozzle, and the first wheel of this character was placed in the Lamphear mine, at Mokelumne Hill, and it was quickly followed by two others, so satisfactorily did they work.

From these wheels sprang the present KNIGHT WATER WHEEL, for here it was he conceived the idea of abandoning entirely any direct modification of the round nozzle, and made the opening a narrow rectangular slit.

The round nozzle did well enough where small quantities of water were used, but upon using considerable water the nozzle became so large that while the upper edge could be brought near the wheel the lower edge was far away, and it reduced the power materially, so the slit was determined upon. More than one nozzle was also tried but it did not prove satisfactory.

In 1875 the first wheel of the present style was placed in the Lincoln mine, at Sutter Creek, and from that time various improvements have been made in the size and arrangement of the slits in the nozzle and shape of the buckets, until at the present time Mr. KNIGHT is manufacturing a wheel for general utility and economy, challenges competition.

The slit form of opening in the nozzle presents a number of vital points.

1st. It allows the nozzle to be made to the curve of the wheel, and thus each part of the opening can be brought to within a bare clearance distance of the buckets; all portions of the water thus enter the buckets with the same force.

2d. If it is desired to increase or diminish the power of the wheel it is not necessary to open or close the gate and thereby throttle the power out of the water, by diminishing its pressure, but it is merely necessary to lengthen or shorten the slit by means of a steel slide as shown in the engraving, and also on page 19.

The shape of the nozzle thus remains the same and the pressure is neither increased nor diminished, but remains constant.

3d. No matter whether the slit be lengthened or shortened the amount of water striking a running inch of bucket is a constant quantity and thus the curves on the bucket can be constant and the head remaining the same. The same conditions will exist when 50 H. P. is given out as for 10, and thus the economy of the wheel is unaltered.

This can never be the case with a round nozzle, for if the curves on the buckets are made for a 2-inch nozzle and a 3-inch nozzle to put on, the relation between the curves on the bucket and the nozzle is destroyed and the economy altered.

4th. The slit affords an easy opportunity of operating a governor as explained on page 23.

Many have objected to the slit nozzle because it seems the natural thing from long association with pipes and hose nozzles, that water should come out of a round opening, but upon investigation and actual experiment they will find the rectangular slit to be the most economical for general purposes.

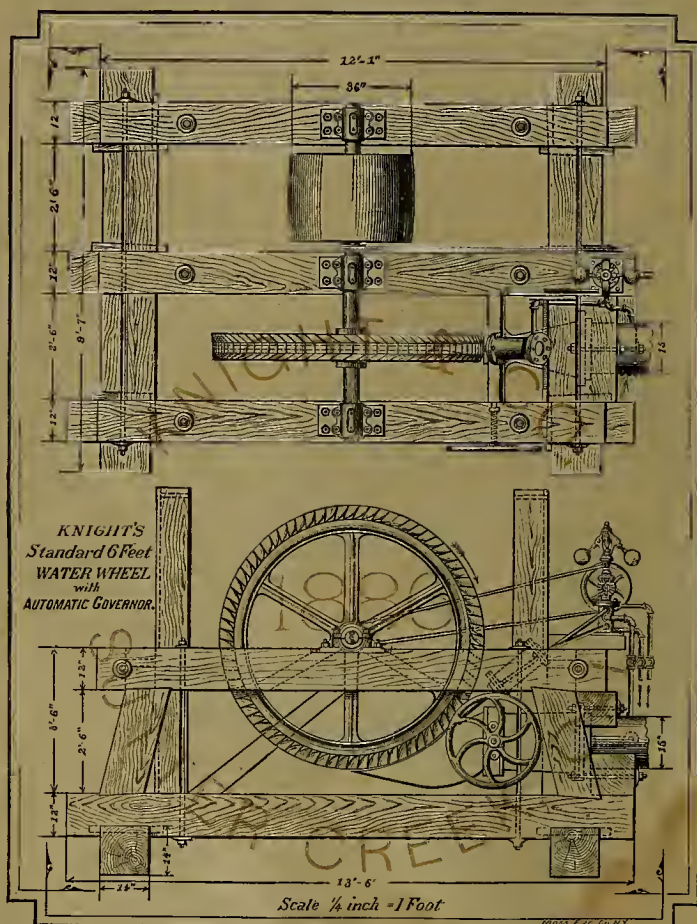
There are over 300 KNIGHT WHEELS in operation in California and many have gone to various parts of the world and all are giving satisfaction.

Numerous attempts have been made by other wheel manufacturers to displace the KNIGHT WATER WHEEL with their own, but in all instances where the personal feeling of friendship or money consideration did not enter into the question, they have failed and of their successes we know of but two or three.

The matter of the so-called Grass Valley test we have reserved for special treatment in another part of our catalogue.

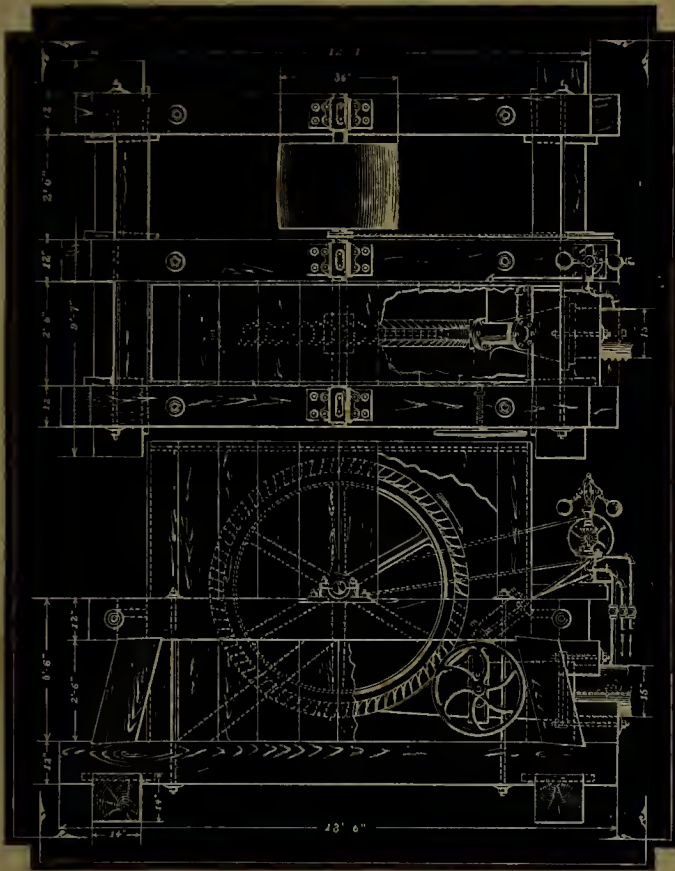
All parties desiring a first-class water wheel, one which we will guarantee in all respects, would do well for themselves by communicating with us, before purchasing. We are always ready and pleased to furnish all information gratis and the estimates and calculations made by our engineers, we are always ready to back up. We contract to deliver water power machinery in running order, as well as F. O. B. cars at Ione, Amador County, Cal.

Knight's 6-foot Water Wheel.



Knight's 6-foot Water Wheel.

METHOD OF SETTING.



The above wheel is 6 feet in diameter and is used in conjunction with the No. 4 gate and nozzle and is intended for heads from 60 feet to 600 feet. The cut is made to show the way a water wheel should be boxed or cased and placed in position.

RUNNING OVER 1900 STAMPS.

By giving attention to the following directions any one will be able to erect the wheel properly:

Frame all the timbers as shown in the cuts, following the sizes as marked, and bolt them together firmly.

Set the frame work on level ground and tamp in the dirt firmly about the mud sills. It is immaterial at what angle the water pipe leads to the wheel, it will work equally well on the top, bottom or any intermediate position, but as the lowest position gives the most power, the nozzle is generally placed on the bottom. At all events it is only necessary that the curve of the nozzle shall be concentric with the wheel, and $\frac{1}{4}$ of an inch away from it, and the slit should be midway of the width of the buckets. The nozzle once in place should be bolted firmly to prevent it getting against the wheel. Plank the bottom of the tail race and board up the wheel from the boxes down on the outside of the timbers; this allows free space for the water to leave the buckets and gives more room to work in, should it be necessary to change the nozzle.

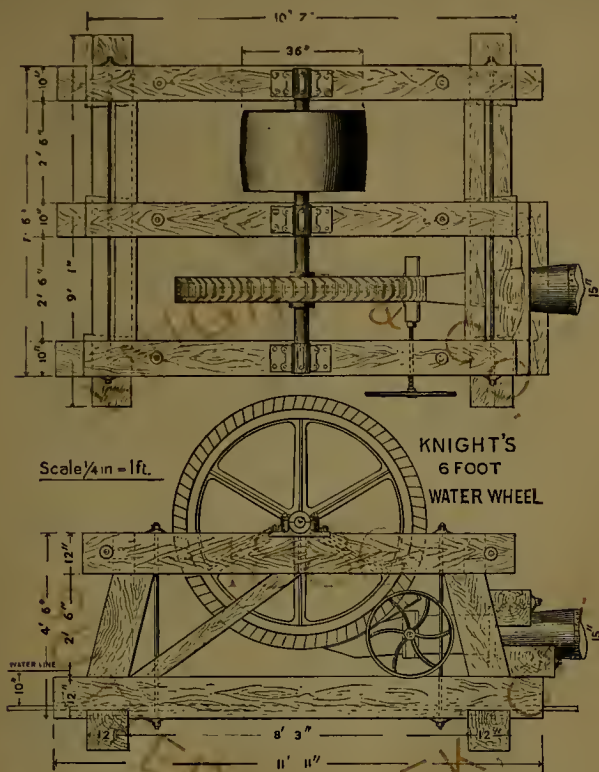
Put a trap door on the side, opposite the nozzle, so a man can get in and take it off if necessary.

Cover over the wheel from the boxes up on the inside of the timber so as to leave the boxes in sight for oiling and adjustment. Make this cover loose so it can be taken off should it become necessary to raise the wheel or otherwise work at it.

After the water is turned on the speed is adjusted by moving in or out the steel slide in the nozzle until the exact number of revolutions is obtained; while doing this the gate should be wide open.

In closing the water gate be sure and shut it completely off, otherwise the water will wear away the seat so that it will always leak. A screen should be placed above the sand box in the flume, else the nozzle is liable to become clogged with leaves and sticks and delays occur.

KNIGHT'S 6-FOOT WATER WHEEL.



The above wheel is 6 feet in diameter and is used in connection with the No. 3 gate and nozzle and is intended for use under heads from 50 feet to 300 feet.

This water wheel is commonly used for driving 40 and 60 stamp mills under a head of 200 feet and upwards.

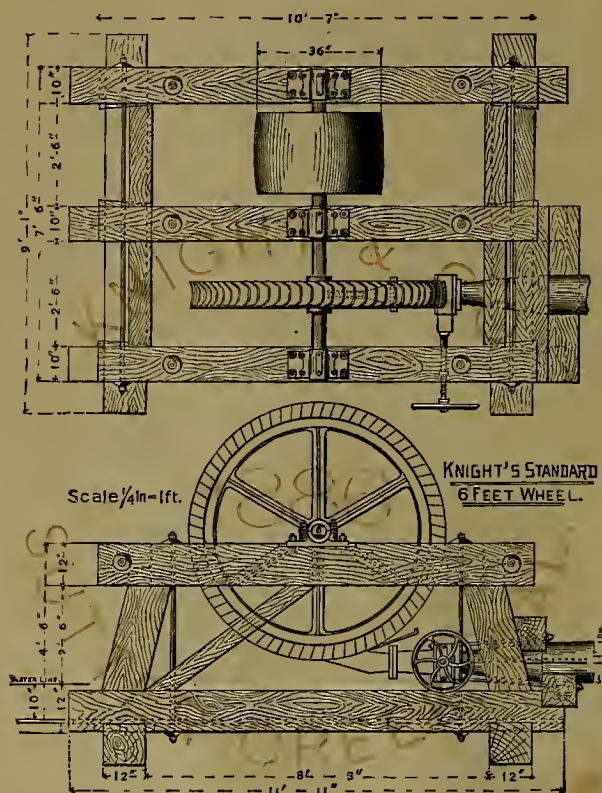
This wheel will develop the following power:

25 H. P. working under a head of 50 feet.	75 H. P. working under a head of 100 feet.
50 H. P. working under a head of 75 feet.	150 H. P. working under a head of 200 feet.
200 H. P. working under a head of 300 feet.	

The weight of this wheel complete is about 3200 lbs., depending on how large a pulley is required. We furnish pulleys of any reasonable size that the speed may require. The same is true of all the other wheels.

RUNNING OVER 1900 STAMPS.

KNIGHT'S 6-FOOT WATER WHEEL.



The above wheel is 6 feet in diameter and is used in connection with the No. 2 gate and nozzle and is intended for heads from 100 to 500 feet and requires but a small amount of water.

This wheel will develop the following power.

35 H. P. under a head of 100 feet.

100 H. P. under a head of 300 feet.

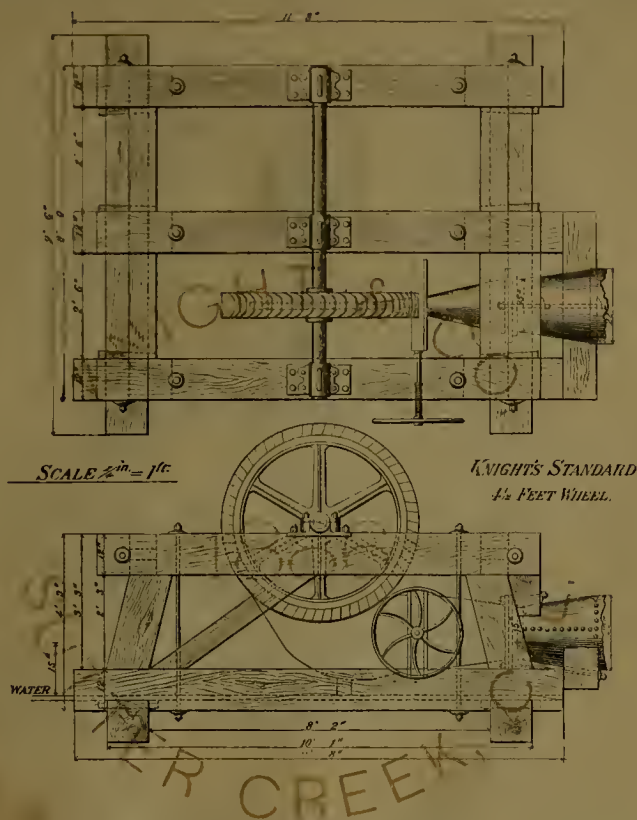
75 H. P. under a head of 200 feet.

150 H. P. under a head of 400 feet.

175 H. P. under a head of 500 feet.

Weight about 2400 lbs., depending on amount of power and size of pulley required.

Knight's $4\frac{1}{2}$ -foot Water Wheel.



The above is the Knight $4\frac{1}{2}$ -foot wheel used in connection with the No. 5 gate and nozzle, and intended for heads from 10 to 75 feet. It is well adapted to quartz mills, for the speed is such that you can belt direct from the water wheel pulley to the cam shaft, thus avoiding the counter-shaft, which is an item in economical construction and operation.

This wheel will develop the following power:

15 H. P. under a head of 10 feet.

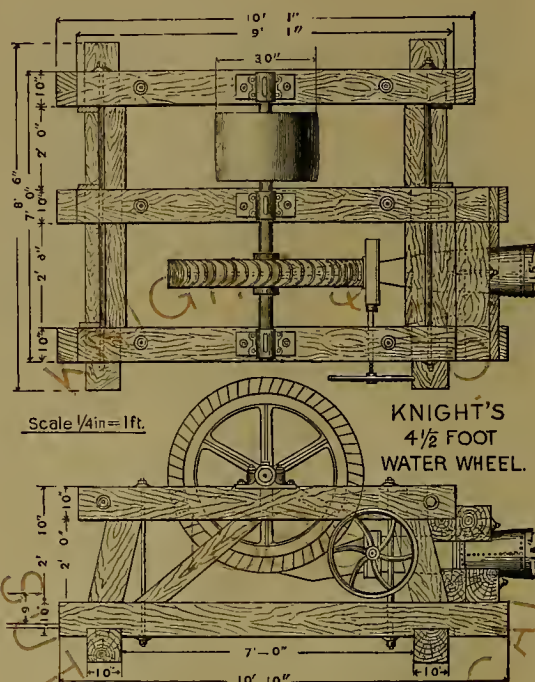
70 H. P. under a head of 50 feet.

35 H. P. under a head of 25 feet.

100 H. P. under a head of 75 feet.

For this wheel add \$35.00 to the regular price list of wheels the same diameter and power. Weight 2500 to 3500, according to power required.

RUNNING OVER 1900 STAMPS.

KNIGHT'S 4 $\frac{1}{2}$ -FOOT WATER WHEEL.

The above wheel is 4 $\frac{1}{2}$ feet in diameter and is used in connection with the No. 3 gate and nozzle and is intended for heads of from 50 to 300 feet.

This is the common size used for driving Hoisting Works, Quartz Mills, Air Compressors and Saw Mills. For Saw Mill use the Patent Hydraulic gate and nozzle is used, which saves the water between cuts and for which an extra price is charged as per list on page 26.

This wheel will develop the following power:

25 H. P. under a head of 50 feet.

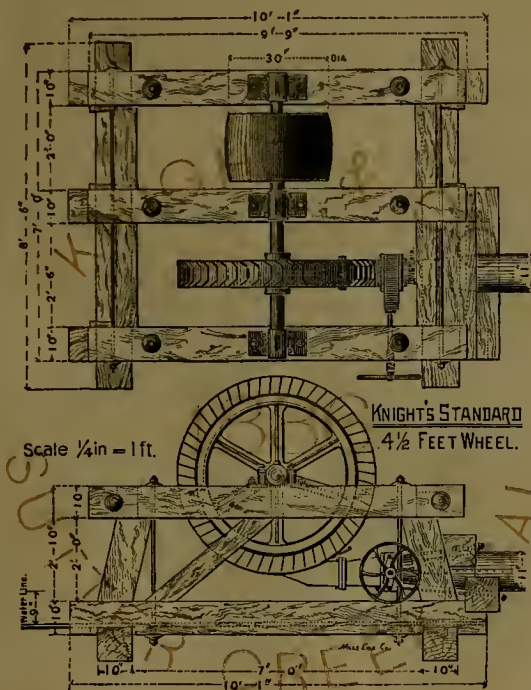
75 H. P. under a head of 100 feet.

50 H. P. under a head of 75 feet.

150 H. P. under a head of 200 feet.

200 H. P. under a head of 300 feet.

Weight 1800 to 2400 lbs., according to horse power required.

KNIGHT'S $4\frac{1}{2}$ -FOOT WATER WHEEL.

The above wheel is $4\frac{1}{2}$ feet in diameter and is used in connection with the No. 2 gate and nozzle, and is intended for heads of water from 100 feet to 500 feet.

This wheel will develop the following power:

35 H. P. under a head of 100 feet.

100 H. P. under a head of 300 feet.

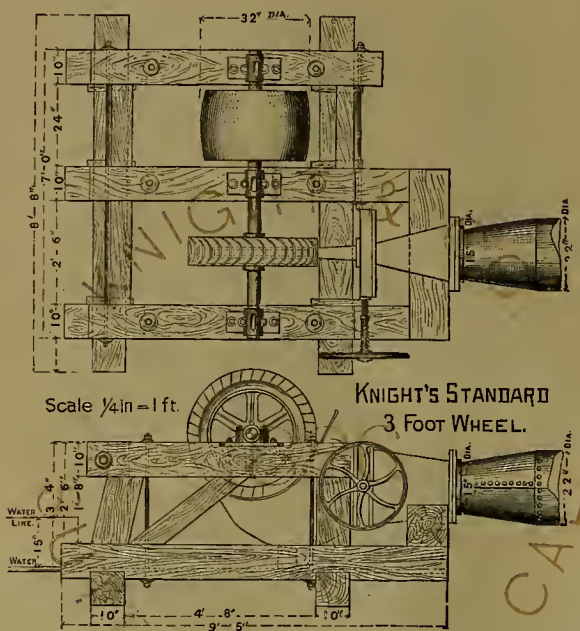
75 H. P. under a head of 200 feet.

150 H. P. under a head of 400 feet.

175 H. P. under a head of 500 feet.

Weight from 1400 to 2200 lbs., depending on the power required.

KNIGHT'S 3-FOOT WATER WHEEL.



The above wheel is 3 feet in diameter and is used in connection with the No. 5 gate and nozzle and is intended for heads of water from 10 to 75 feet

This wheel will develop the following power:

15 H. P. under a head of 10 feet.

70 H. P. under a head of 50 feet.

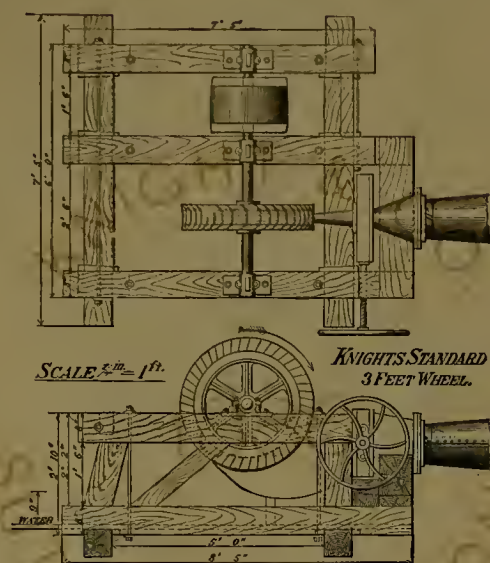
35 H. P. under a head of 25 feet.

100 H. P. under a head of 75 feet.

For this wheel add \$35.00 to the regular price list of wheels the same diameter and capacity.

Weight 2000 to 3000 lbs., according to power required.

KNIGHT'S 3-FOOT WATER WHEEL.



The above wheel is 3 feet in diameter and is used in connection with the No. 4 gate and nozzle and is intended for heads of water from 25 to 100 feet.

The heaviest piece is the water wheel, which weighs 350 lbs., and can be packed on a good mule.

This wheel will develop the following power:

15 H. P. under a head of 25 feet.

75 H. P. under a head of 60 feet.

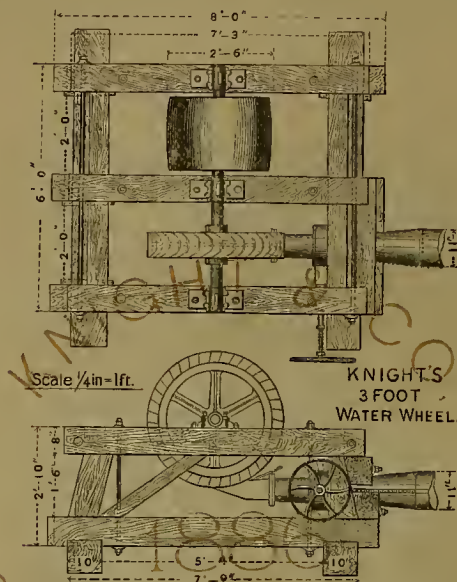
50 H. P. under a head of 40 feet.

130 H. P. under a head of 100 feet.

For this wheel add \$20.00 to the regular price list of same size and power.

Weight 1500 to 2000 lbs., according to H. P. required.

Knight's 3-foot Water Wheel.



The above wheel is 3 feet in diameter and is used in conjunction with the No. 2 gate and nozzle, and is intended for heads of water from 50 feet to 300 feet and over. It is a very light wheel and easily transported over the roughest mountain trails. The wheel itself boxed weighs about 300 pounds and is the heaviest piece.

This wheel is very desirable for use in saw mills where a high speed is required, saving the expense and trouble of gearing and countershafts. Where the head is high enough, they can be put on the saw shaft directly, and be operated by one of Knight's Patent Hydraulic Gates, by means of which the water can be closed off as the saw is going out of cut, and all the water saved between cuts, thus running the mill on about one half the water.

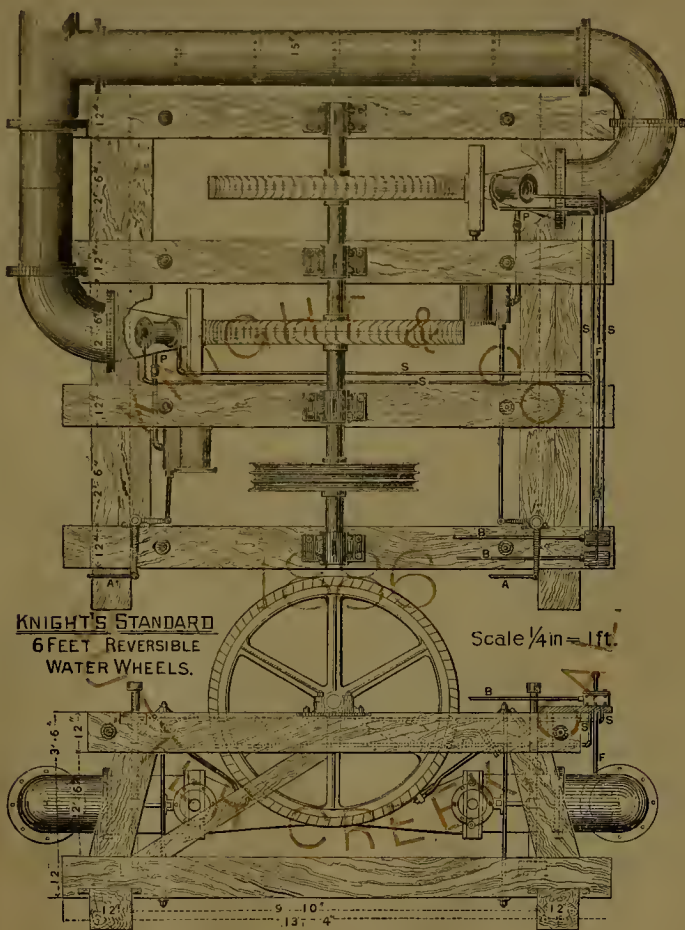
Extra charge will be made for the Hydraulic Gate attachment, for which see price list on page 21.

This wheel will develop the following power:

15 H. P. under a head of 50 feet.	35 H. P. under a head of 100 feet.
25 H. P. under a head of 75 feet.	75 H. P. under a head of 200 feet.
100 H. P. under a head of 300 feet.	

Weight 1000 to 1500 pounds according to H. P. required.

Knight's Reversible Water Wheels.



Patented Nov. 7, 1882.

The above represents the Knight 6-foot Reversible Water Wheels used in connection with the No. 4 gate and nozzle, under heads from 125 to 250 feet and will develop from 100 to 200 Horse Power under the above heads. This is planned especially to take the place of engines, working at mines, where owners wish to make the change in the least expensive way possible, in order to utilize water power instead of steam.

RUNNING OVER 1900 STAMPS.

We advocate the transmission of power to the reel shaft by manilla ropes or cotton made expressly for the purpose. The nozzles are so arranged that the engineer can increase or diminish the speed of the cage or bucket as he chooses, while the hoisting is in progress. This is effected by means of a Hydraulic Cylinder attached to the nozzle, the piston rod being a continuation of the steel slide covering the slit. B. B. B. are two valve stems leading to the engineer's platform; these operate the valves in the water chests bolted to the frame work as shown and which are fed by water from the main supply pipe through the pipe F.

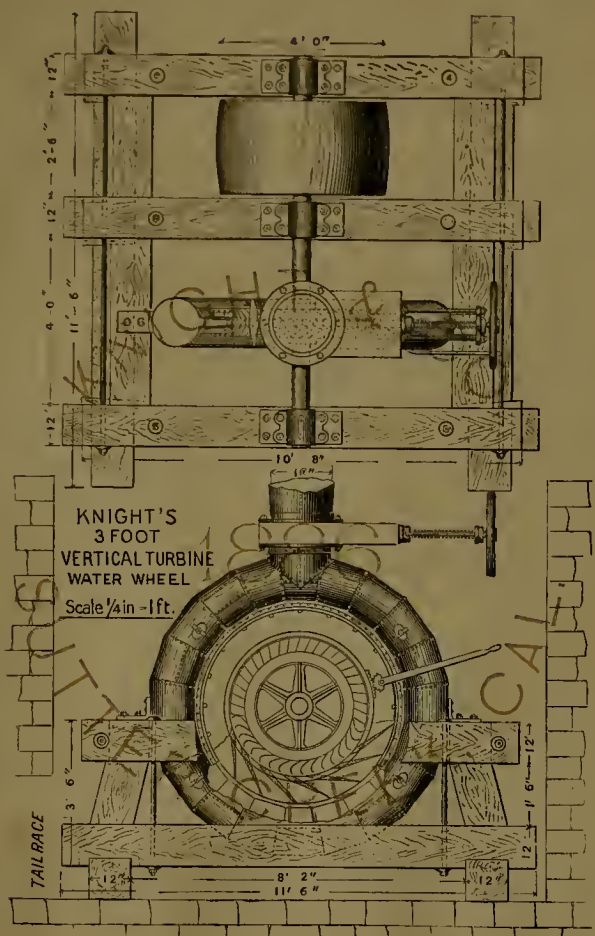
The four pipes S. S. S. S. lead from the water chest to the cylinder on the nozzles, and are the feed and exhaust pipes that supply and take away the water from that cylinder, thus controlling the motion of the piston which in turn moves the slide back and forth. The increasing or diminishing thus of the size of nozzle admits more or less water and consequently increases or diminishes the speed to suit the kind of hoisting that may be desired at the time.

When the cage arrives at the top of the shaft the engineer moves the rod A. A.; this is connected to the rock shaft that moves the valve stem on the main hydraulic gates. This closes off the water completely. This cylinder is supplied with water by the pipe P. P. connected to the main supply pipe. By all of these patented contrivances, this application of water power is made fully equal in desirability to any steam engine.

Price of reversible water wheel complete \$1100. If the pressure is very high the cost would be less.

The above price does not include frame work. If desired we furnish frame work and set everything in position for \$175.00 extra.

Knight's 3-foot Vertical Turbine.



The above is Knight's 3-foot Vertical Turbine which is intended to develop a large power under heads of from 10 feet to 50 feet. In the vertical elevation in the above cut, the frame work is cut away and also a portion of the sheet iron piping, in order to show the guide curves for conducting the water on to the buckets, and also to show the adjustable circular nozzle for regulating the power or speed, and which is operated by the hand lever shown.

RUNNING OVER 1900 STAMPS.

It is often necessary to set the water wheel horizontal to accommodate certain classes of machinery, such as Flouring Mills and Vertical Centrifugal Pumps. When using these water wheels horizontally, there is no gearing or step under the water wheel shaft, the entire weight resting on two 26-inch friction wheels, and a steel tappet keyed to the water wheel shaft. A greater fall of water can be utilized by running the wheel horizontally.

We make the following sizes of the Vertical Turbine:

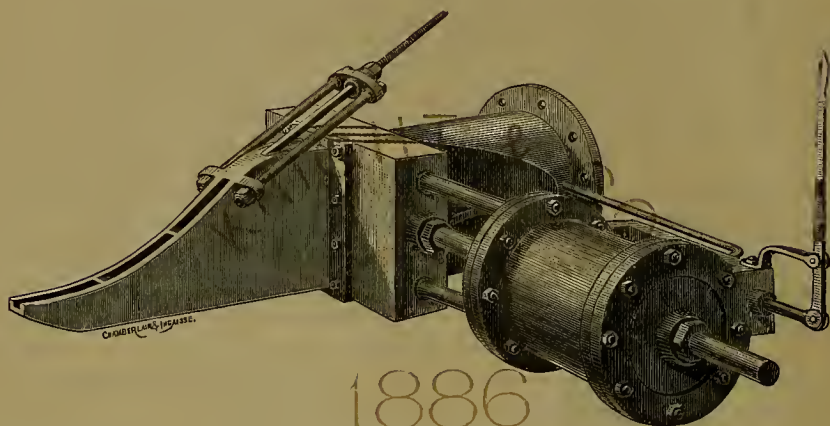
INCHES.	H. P. 10'	H. P. 15'	H. P. 20'	H. P. 25'	H. P. 30'	PRICE.	WEIGHT.
8	2	3.5	5	7	8	\$ 245	800
10	2.5	5	7	8.5	10	275	900
12	3	6.5	9	10	12	300	1000
15	5	7.5	9	12	15	325	1100
36	25	35	45	60	70	500	2500 to 4000

Speed will be same as shown on Table, page 27.

The foregoing wheel can be made very light when required to save high rates of freight or for mule packing, for which an extra charge of 10 per cent. will be made.

These wheels can be made without the adjustable nozzle, if desired to save expense. Parties erecting them can plug the guide curves with wood to decrease the power. This will make a reduction of \$20 on all wheels except the 3 foot which will be \$25.

Knight's Patent Hydraulic Gate.



1886
Patented Nov. 7, 1882.

The above is the cut of Knight's Patent Hydraulic Gate, attached to a nozzle and operated by an ordinary hand lever.

The gate is opened and closed by means of water pressure applied to the hydraulic cylinder which is attached to the gate stem. By this means a child can open or close with ease a 22-inch gate under a pressure of 500 feet, that would require two men to work hard to open, in from three to four minutes.

By placing in the cylinder special exhaust ports, the piston is made to close or open the gate at once or slowly.

Any one at a glance can see of what vital importance this contrivance is to water power machinery. No hoisting works can be properly constructed without it, and a great saving can be effected, where a company has a dam or reservoir, by using this gate.

Take the case of a water wheel used in running a saw mill, where the power is used less than one-half the time. Without this contrivance it would be necessary to run the water all the time on account of the great inconvenience in closing and opening the gate, but with this attachment as soon as the cut is through the water can be closed off, and if there is a reservoir it accumulates, and the mill can be run on about one-half the quantity it otherwise would take.

The Idaho Mining Company of Grass Valley, who are using the Pelton wheel, purchased our Patent Hydraulic Cylinder and all their attachments for operating these wheels attached to their hoisting works.

Cut on page 15 shows two of these gates operating reversible wheels for hoisting.

Persons are hereby cautioned against using a Hydraulic Cylinder in any shape or form for closing a water wheel gate, as this is covered by our letters Patent, and we shall enjoin parties from using the same, and subject them to payment of damages.

Following is our price for the different sizes of plain gates and also Hydraulic gates.

No.	Opening of Valves. Inches.	Number of Openings.	Diameter of Hydraulic Cylinder. Inches.	Price of Gate Nozzle and Handwheel.	Price of Hydraulic Gate.
1	2 x 3	1	4	\$ 50	\$140
2	2 x 5	1	5½	75	180
3	2½ x 10	2	6½	100	210
4	3 x 15	3	8½	130	250
5	3 x 26	6	10	175	315

Hydraulic Gate includes rock shaft, boxes and levers.

Knight's Hydraulic Hoisting Works.

One of the principal uses to which water wheels are now put, is that of driving hoisting reels for mining purposes. Not only is it far more economical, but it gives a steady, reliable motion, and is much easier to operate than steam hoists.

All of our hoisting works are operated by Knight's Patent Hydraulic Gate, by means of which the engineer can, with the smallest movement of his lever, control the action of the water, stopping the cage instantly if necessary.

It is generally intended in most hoisting works to lower the cage with the brake, but in some mines we have placed an additional wheel reversed on the shaft for lowering with power. This is also fitted up with the Hydraulic Gate and is independent from the other wheel, and can be used or not as may be desired. Special mention is made of the reversible wheels on page 15.

We build any sizes that may be required of these hoisting works.

Our regular pattern list includes four sizes, orders for which we are ready to fill at the shortest notice.

All of our work we guarantee and deliver in running order if required.

We furnish our hoisting works with either single or double reels as may be required, prices for which we quote as follows:

NO.	Diameter of Winding Drum. Feet.	Diameter of Friction Wheel. Feet.	Diameter of Sheaves. Inches.	Diameter of Water Wheel. Feet.	WEIGHT. Lbs.	Price of Single Drum Machine.	Price of Double Drum Machine.	Additional Price for Reversible Wheel.
1	3	3.6	30	3	5000	\$ 650	\$ 850	\$ 200
2	4.4	5.0	48	4.6	10000	1100	1400	300
3	5.6	6.0	48	4.6	12000	1200	1500	500
4	7.6	8.6	60	6.0	24000	2000	2500	800

The following parties are using our Hoisting Works or our Patented Appliances:

Pacific Mine,	-	-	-	-	-	Placerville, Cal.
El Dorado Water and D. G. Co.	-	-	-	-	-	Placerville, Cal.
Butte Basin Mining Co.	-	-	-	-	-	Jackson, Cal.
Patterson Mining Company,	-	-	-	-	-	Tuttletown, Cal.
Lincoln Mining Company,	-	-	-	-	-	Sutter Creek Cal.
Sierra Buttes Company,	-	-	-	-	-	Sierra City, Cal.
Idaho Mining Company,	-	-	-	-	-	Grass Valley, Cal.
Kennedy Mining Company,	-	-	-	-	-	Jackson, Cal.

Knight's Hydraulic Governor.

We manufacture and can attach to all water wheels our Hydraulic Governor for regulating the speed of the wheel to suit different requirements. One can be seen on page 4 of this catalogue, attached to a six-foot wheel. On the nozzle there is an Hydraulic Cylinder which moves back and forth the steel slide in the slit of the nozzle, thus increasing and diminishing the flow of water and consequently the power and speed.

This cylinder is supplied with water by small pipes running from the Hydraulic valve chest under the Governor, the valve in this being operated by the raising or lowering of the Governor balls, which in turn is moved by a belt from the water wheel shaft, all as shown in the engraving. This is the only method by which water wheels can be regulated and yet retain the same percentage of power. It cannot be done on a round nozzle.

The Governor shown is used for clear water. When muddy water only is available, we make another kind of Governor that works the slide in the nozzle by means of gearing. Parties ordering Governors should state what kind of water is used, so we may know which kind to send. Also what is the extreme variation in speed that may be allowed and what extreme variation of power is likely to occur. The price is \$175.00 boxed

Knight's Improved Safety Valve.

(FOR WATER ONLY.)

We manufacture an improved safety valve for relieving the shock on the water pipe when the water is closed off suddenly. By using our safety valve the iron used in making the pipe can be made lighter than without it, saving many times the cost of the contrivance in a long line of pipe.

Under a head of 200 feet by actual experiment, the water can be closed off suddenly and the gauge registered a pressure of but 8 lbs. increased pressure, whereas, under ordinary circumstances, it would have raised from 30 to 40 lbs.

Where such a small item of expense is incurred by putting on these safety valves, no owner should run the risk of straining and perhaps bursting his pipes. The price is \$175.00, boxed, weight 400 lbs.

NOTICE TO PURCHASERS.

♦ ♦ ♦

In ordering give information mentioned below. Give address or shipping mark in full, so no mistakes will be made. Prices in this catalogue will be adhered to as closely as possible; we reserve the right, however, to change prices without notice.

As we use every precaution in packing and shipping our machinery no allowance can be made if goods are damaged either in direct shipments or enclosure through other houses.

Boxing if required will be charged at cost.

All goods are delivered at Freight Depot, Ione, Amador Co., Cal., free.

Remittance can be made either by bank-draft, payable to our order, or cash sent by any of the Express Companies, or by P. O. Money order. If cash is sent by mail the letter should be registered.

Remittances are in all cases at the risk of sender.

For goods ordered by express and bill to be collected on delivery, a small remittance should accompany order.

Express charges for collection will be added to amount of bill.

Regular customers are allowed 30 days' time on payments.

Purchasers who find anything wrong with any of our manufactures are requested to notify us at once and if we have made any error we will rectify same at our expense.

Correspondence is solicited from all parties thinking of using water power, and estimates and information will be furnished free of cost.

Information Correspondents should give, in writing for Water Wheels.

1. Head of water, measured from ditch or water source to point of application, in vertical feet.
2. Amount of water per minute in inches, cubic feet, or gallons.
3. Power expected to be realized; if unknown, describe the machinery to be run.
4. Distance of ditch or water source from water wheel, measured along the ground, for length of pipe.
5. If for pumping purposes, how much water is to be pumped and how high.
6. If you have counter-shafts, or other shafts to belt to, give speeds of same.
7. State whether you want Reversible Wheels, Hydraulic Gates, Governors, or Safety Valves in connection with your work.
8. State whether water is clear or muddy.

PRICE LIST OF KNIGHT'S WATER WHEELS.

Diameter of Wheels.	2	5	10	20	30	40	60	80	100	200	300	400
	H. P.	H. P.	H. P.	H. P.	H. P.	H. P.	H. P.	H. P.	H. P.	H. P.	H. P.	H. P.
FEET.												
1.6	\$82	\$125	\$130	\$150	.....	.....	.....	.....	.....	.....	.....	.....
2.6	.....	150	160	170	\$180	.....	.....	.....	.....	.....	.....	.....
3	.....	.....	165	175	185	\$195	\$220	\$250	\$300	\$350	.....	.....
4.6	.....	.....	.....	200	220	250	275	300	350	400	\$450	\$500
6	.....	.....	.....	.....	275	300	330	385	400	450	500	550
8	.....	.....	.....	.....	.....	400	420	450	500	550	600	650

The above prices include the wheel boxes, shaft, gate nozzle and a pulley to suit the speed required; provided, however, that it shall not exceed two-thirds the diameter of the wheel. If larger than this is wanted, an extra price will be charged.

Above prices are delivered at R. R. station at Ione, Cal.

For price on Turbine Wheel see page 18.

For price on Brass Wheels see page 19.

Table Showing Diameter, Working Revolutions and Head

FOR

KNIGHT'S WATER WHEELS.

Head in Feet.	DIAMETER OF WHEELS IN FEET.						Head in Feet.	DIAMETER OF WHEELS IN FEET.					
	1½	2½	3	4½	6	8		1½	2½	3	4½	6	8
	WORKING REVOLUTIONS PER MINUTE.							WORKING REVOLUTIONS PER MINUTE.					
10	160	96	80	53	40	30							
15	186	111	93	62	46	34	240	730	438	365	243	182	136
20	210	126	105	70	52	39	250	745	447	372	248	186	139
30	258	154	129	86	64	48	260	760	456	380	253	190	142
40	298	178	149	99	74	55	270	774	464	387	258	193	145
50	333	199	166	111	83	62	280	788	472	394	262	197	148
60	365	219	182	121	91	68	290	802	481	401	267	200	150
70	394	236	197	131	98	73	300	816	489	408	272	204	153
80	421	252	210	140	105	79	320	833	499	416	277	208	156
90	447	268	223	149	111	83	340	868	520	434	289	217	162
100	472	283	236	157	118	88	360	893	535	446	297	223	167
110	494	296	247	164	123	92	380	918	550	459	306	229	171
120	516	309	258	175	129	96	400	942	565	471	314	235	176
130	537	322	268	179	134	100	420	965	579	487	321	243	182
140	556	333	278	185	139	104	440	988	592	494	329	247	185
150	577	346	288	192	144	108	460	1011	606	505	337	252	189
160	597	358	298	192	149	112	480	1032	619	516	344	258	193
170	614	368	307	204	153	115	500	1054	632	527	351	263	197
180	632	379	316	210	158	118	520	1074	644	537	358	268	201
190	649	389	324	216	162	121	540	1094	656	547	364	273	204
200	665	399	332	221	166	124	560	1115	669	557	372	278	208
210	682	409	341	227	170	127	580	1134	680	567	378	283	212
220	699	419	349	233	174	130	600	1154	692	577	384	288	216
230	714	428	357	238	178	133	620	1175	705	587	391	293	220

The above table gives the slowest speed for the Knight Wheel that will give high percentage. Three to four per cent. may be added to suit pulleys and speed of line shafting without making material difference. In saw mill machinery it would be well to speed the wheel from fifteen to twenty per cent. in excess of above tables.

This, although not giving so high a percentage of power from the water used, will be found beneficial, because the saw, in going out of cut, will not increase so rapidly in speed, and the governor will have more opportunity to act.

TABLE OF HORSE POWERS

FOR

KNIGHT'S WATER WHEELS.

Calculated for 1 inch—1.45 Cubic Feet.

USED BY

South Yuba Canal Co., Union Water Co., El Dorado Water and Ditch Co., Park Canal and Mining Co., and Eureka Lake and Canal Co.

Discharge per minute.	Miner's Inch.	5	10	20	30	40	50	60	70
	Cubic Feet.	7.25	1.45	29	43.5	58	72.5	97	101.5
Head in Feet.	H. P.	H. P.	H. P.	H. P.	H. P.	H. P.	H. P.	H. P.	H. P.
10	.11	.22	.44	.66	.88	1.10	1.32	1.54	
15	.18	.36	.72	1.08	1.44	1.80	2.16	2.52	
20	.23	.46	.92	1.38	1.84	2.30	2.76	3.22	
30	.34	.72	1.44	2.16	2.88	3.60	4.32	5.04	
40	.46	.92	1.84	2.76	3.68	4.60	5.52	6.44	
50	.57	1.14	2.28	3.42	4.56	5.70	6.84	7.98	
60	.69	1.38	2.76	4.14	5.52	6.90	8.28	9.66	
70	.80	1.60	3.20	4.80	6.40	8.00	9.60	11.20	
80	.92	1.84	3.68	5.54	7.36	9.20	11.08	12.88	
90	1.05	2.10	4.20	6.30	8.40	10.50	12.60	14.70	
100	1.26	2.52	5.04	7.56	10.08	12.60	15.12	17.64	
110	1.38	2.76	5.52	8.28	11.04	13.80	16.48	19.32	
120	1.51	3.02	6.04	9.06	12.08	15.10	18.12	21.14	
130	1.62	3.24	6.48	9.72	12.96	16.20	19.44	22.68	
140	1.74	3.48	6.96	10.44	13.92	17.40	20.88	24.36	
150	1.85	3.70	7.40	11.10	14.80	18.50	22.20	25.90	
160	1.98	3.96	7.92	11.88	15.84	19.80	23.76	28.72	
170	2.08	4.16	8.32	12.48	16.64	20.80	24.96	29.12	
180	2.09	4.18	8.36	12.54	16.72	20.90	25.08	29.26	
190	2.19	4.38	8.76	13.14	17.52	21.90	26.28	30.66	
200	2.31	4.62	9.24	13.86	18.48	23.10	27.72	32.34	
210	2.40	4.80	9.60	14.46	19.20	24.00	28.92	33.60	
220	2.52	5.04	10.08	15.12	20.16	25.20	30.24	35.28	
230	2.63	5.26	10.52	15.78	21.04	26.30	31.56	36.82	
240	2.75	5.50	11.00	16.50	22.00	27.50	33.00	38.50	
250	2.86	5.72	11.44	17.16	22.88	28.60	34.32	40.04	
260	2.97	5.94	11.88	17.82	23.76	29.70	35.64	41.58	
270	3.09	6.18	12.36	18.54	24.72	30.90	37.08	43.26	
280	3.20	6.40	12.80	19.20	25.60	32.00	38.40	44.80	
290	3.32	6.64	13.28	19.92	26.56	33.20	39.84	46.48	
300	3.43	6.86	13.72	20.58	27.44	34.30	41.16	48.02	
320	3.66	7.32	14.64	21.96	29.28	36.00	43.92	51.24	
340	3.89	7.78	15.56	23.34	31.12	38.50	46.68	54.46	
360	4.12	8.24	16.48	24.74	32.96	41.20	49.48	57.68	
380	4.35	8.70	17.40	26.10	34.80	43.50	52.20	60.90	
400	4.59	9.18	18.36	27.54	36.72	45.90	55.08	64.26	
420	4.82	9.64	19.28	28.92	38.56	48.20	57.84	67.48	
440	5.04	10.08	20.16	30.24	40.32	50.40	60.48	70.56	
460	5.27	10.54	21.08	31.62	42.16	52.70	63.24	73.78	
480	5.50	11.00	22.00	33.00	44.00	55.00	66.00	77.00	
500	5.73	11.46	22.92	34.38	45.84	57.30	68.76	80.22	
520	5.97	11.94	23.88	35.82	47.76	59.70	71.64	83.58	
540	6.20	12.40	24.80	37.20	49.60	62.00	74.40	86.60	
560	6.42	12.84	25.68	38.52	51.36	64.20	77.04	89.88	
580	6.65	13.30	26.60	39.90	53.20	66.50	79.80	93.10	
600	6.87	13.74	27.48	41.22	54.96	68.70	82.44	96.18	

TABLE OF HORSE POWERS

FOR

KNIGHT'S WATER WHEELS.

Calculated for 1 inch 1.45 Cubic Feet.

USED BY

South Yuba Canal Co., Union Water Co., El Dorado Water and Ditch Co., Park Canal and Mining Co., and Eureka Lake and Canal Co.

Discharge per minute.	Miner's Inch.	80	90	100	120	140	160	180	200
	Cubic Feet.	116	130.5	145	174	203	232	261	290
Head in Feet.	H. P.	H. P.	H. P.	H. P.	H. P.	H. P.	H. P.	H. P.	H. P.
10	1.76	1.98	2.20	2.64	3.08	3.52	3.96	4.40	
15	2.88	3.24	3.60	4.32	5.04	5.76	6.48	7.20	
20	3.68	4.14	4.60	5.92	6.44	7.36	8.28	9.20	
30	5.76	6.48	7.20	8.64	10.08	11.52	12.96	14.40	
40	7.36	8.28	9.20	11.04	12.88	14.72	16.56	18.40	
50	9.12	10.26	11.40	13.68	15.96	18.24	20.52	22.80	
60	11.04	12.42	13.80	16.56	19.32	22.08	24.84	27.60	
70	12.80	14.40	16.00	19.26	22.40	25.60	28.80	32.00	
80	14.72	16.56	18.40	22.16	25.76	29.44	32.12	36.80	
90	16.80	18.90	21.00	25.20	29.40	33.60	37.80	42.00	
100	20.16	22.68	25.20	30.24	35.28	40.32	41.36	50.40	
110	22.08	24.84	27.60	32.96	38.64	44.16	49.68	55.20	
120	24.16	27.18	30.20	36.24	42.28	48.32	54.36	60.40	
130	25.92	29.16	32.40	38.88	45.36	51.84	58.32	64.80	
140	27.84	31.32	34.80	41.76	48.72	55.68	62.64	69.60	
150	29.60	33.30	37.00	44.40	51.80	59.20	66.60	74.00	
160	31.68	35.64	39.60	47.52	57.44	63.36	71.28	79.20	
170	33.28	37.44	41.60	49.92	58.24	66.56	74.88	83.20	
180	33.44	37.62	41.80	50.16	58.52	66.88	75.24	83.60	
190	35.04	39.42	43.80	52.56	61.32	70.08	78.84	87.60	
200	36.96	41.58	46.20	55.44	64.68	73.92	83.16	92.40	
210	38.40	43.20	48.00	57.84	67.20	76.80	86.40	96.00	
220	40.32	45.36	50.40	60.48	70.56	80.64	90.72	180.00	
230	42.08	47.34	52.60	63.12	73.64	84.16	94.68	105.20	
240	44.00	49.50	55.00	66.00	77.00	88.00	99.00	110.00	
250	45.76	51.48	57.20	68.64	80.08	91.52	102.96	114.40	
260	47.52	53.46	59.40	71.28	83.16	95.04	106.92	118.80	
270	49.44	55.62	61.80	74.16	86.52	98.88	111.24	123.60	
280	51.20	57.60	64.00	76.80	89.40	102.40	115.20	128.00	
290	53.12	59.76	66.40	79.68	92.96	106.24	119.52	132.80	
300	54.88	61.74	68.60	82.32	96.04	109.76	123.48	137.20	
320	58.56	65.88	73.20	87.54	102.48	117.12	131.76	146.60	
340	62.24	70.02	77.80	93.36	108.92	124.48	140.04	155.60	
360	65.92	74.16	82.40	98.96	115.36	131.84	148.32	164.80	
380	69.60	78.30	87.00	104.40	121.80	139.20	156.60	174.00	
400	73.44	82.62	91.80	110.16	128.52	146.88	165.24	183.60	
420	77.12	86.76	96.40	115.68	134.96	154.24	173.52	192.80	
440	80.64	90.72	100.80	120.96	141.12	161.28	181.44	201.60	
460	84.32	94.86	105.40	126.48	147.56	168.64	189.72	210.80	
480	88.00	99.00	110.00	132.00	154.00	176.00	198.00	220.00	
500	91.68	103.14	114.60	137.52	160.44	183.36	206.28	229.20	
520	95.52	107.46	119.40	143.28	167.16	191.04	214.92	238.80	
540	99.20	111.60	124.00	148.80	173.60	198.40	223.20	248.00	
560	102.72	115.56	128.40	154.08	179.76	205.44	231.12	256.80	
580	106.40	119.70	133.00	159.60	186.20	212.80	239.40	266.00	
600	109.92	123.66	137.40	164.88	192.36	219.84	247.32	274.80	

RUNNING OVER 1900 STAMPS.

TABLE OF HORSE POWERS

FOR

KNIGHT'S WATER WHEELS.

Calculated for 1 inch=1.6 cubic feet.

USED BY

North Bloomfield, Milton and La Grange Ditches.

Discharge per minute.	Miner's Inch.	5	10	20	30	40	50	60	70
	Cubic Feet.	8	16	32	48	64	80	96	112
Head in Feet.	H. P.	H. P.	H. P.	H. P.	H. P.	H. P.	H. P.	H. P.	H. P.
10	.12	.24	.48	.72	.96	1.20	1.44	1.68	1.92
15	.19	.38	.76	1.14	1.52	1.90	2.28	2.66	3.04
20	.25	.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
30	.37	.74	1.48	2.22	2.96	3.70	4.44	5.18	5.92
40	.50	1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00
50	.63	1.26	2.52	3.78	5.04	6.30	7.56	8.82	10.08
60	.76	1.52	3.04	4.56	6.08	7.60	9.12	10.64	12.16
70	.88	1.76	3.52	5.28	7.04	8.80	10.56	12.32	14.08
80	1.01	2.02	4.04	6.06	8.08	10.10	12.12	14.14	16.16
90	1.13	2.26	4.52	6.78	9.04	11.30	13.56	15.82	18.08
100	1.26	2.52	5.04	7.56	10.08	12.60	15.12	17.64	20.16
110	1.38	2.76	5.52	8.28	11.04	13.80	16.56	19.32	22.08
120	1.51	3.02	6.04	9.06	12.08	15.10	18.12	21.14	23.96
130	1.63	3.26	6.52	9.78	13.04	16.30	19.56	22.82	25.84
140	1.25	2.50	5.00	7.50	10.00	12.50	15.00	17.50	20.00
150	1.39	2.78	5.56	8.34	11.22	13.90	16.68	19.46	22.24
160	1.50	3.00	6.00	9.00	12.00	15.00	18.00	21.00	24.00
170	2.13	4.26	8.52	12.78	17.04	21.30	25.56	29.82	34.08
180	2.27	4.54	9.08	13.62	18.16	22.70	27.24	31.78	35.92
190	2.39	4.78	9.56	14.34	19.12	23.90	28.68	33.46	37.74
200	2.52	5.04	10.08	15.12	20.16	25.20	30.24	35.28	39.60
210	2.64	5.28	10.56	15.84	21.12	26.40	31.68	36.96	41.52
220	2.77	5.54	11.08	16.62	22.16	27.70	33.24	38.78	43.46
230	2.89	5.78	11.56	17.34	23.12	28.90	34.68	40.46	45.34
240	3.02	6.04	12.08	18.12	24.16	30.20	36.24	42.28	47.28
250	3.15	6.30	12.60	18.90	25.20	31.50	37.80	44.10	49.20
260	3.28	6.56	13.12	19.68	26.24	32.80	39.36	45.92	51.14
270	3.40	6.80	13.60	20.40	27.20	34.00	40.80	47.60	53.08
280	3.53	7.06	14.12	21.18	28.24	35.30	42.36	49.42	55.02
290	3.65	7.30	14.60	21.90	29.20	36.50	43.80	51.10	56.96
300	3.79	7.58	15.16	22.74	30.32	37.90	45.48	53.06	58.90
320	4.02	8.04	16.08	24.12	32.16	40.20	48.24	56.28	61.84
340	4.28	8.56	17.12	25.68	34.24	42.80	51.36	59.92	64.78
360	4.48	8.96	17.92	26.88	35.84	44.50	53.76	62.72	66.72
380	4.88	9.76	19.52	29.28	39.04	48.80	58.56	68.32	72.16
400	5.01	10.02	20.04	30.06	40.08	50.10	60.12	70.14	74.06
420	5.29	10.58	21.16	31.74	42.32	52.90	63.48	74.06	77.56
440	5.54	11.08	22.16	33.24	44.32	55.40	66.48	77.56	80.96
460	5.79	11.58	23.16	34.74	46.32	57.90	69.48	80.96	84.40
480	6.05	12.10	24.20	36.30	48.40	60.50	72.60	84.70	88.20
500	6.30	12.60	25.20	37.80	50.40	63.00	75.60	88.20	91.70
520	6.55	13.10	26.20	39.30	52.40	65.50	78.60	91.70	95.34
540	6.81	13.62	27.24	40.86	54.48	68.10	81.72	95.34	98.84
560	7.06	14.12	28.24	42.36	56.48	70.60	84.72	98.84	102.34
580	7.31	14.62	29.24	43.86	58.48	73.10	87.72	102.34	105.84
600	7.56	15.12	30.24	45.36	60.48	75.60	90.72	105.84	

TABLE OF HORSE POWERS

FOR

KNIGHT'S WATER WHEELS.

Calculated for 1 inch - 1.6 Cubic Feet.

USED BY

North Bloomfield, Milton and La Grange Ditches.

Discharge per minute	Miner's Inch.	80	90	100	120	140	160	180	200
Cubic Feet.		128	144	160	192	224	256	288	320
Head in Feet.		H. P.	H. P.	H. P.	H. P.	H. P.	H. P.	H. P.	H. P.
10	1.92	2.16	2.40	2.88	2.96	3.84	4.32	4.80	
15	3.04	3.42	3.80	4.56	5.32	6.08	6.84	7.60	
20	4.00	4.50	5.00	6.00	7.00	8.00	9.00	10.00	
30	5.92	6.66	7.40	8.88	10.36	11.84	13.32	14.80	
40	8.00	9.00	10.00	12.00	14.00	16.00	18.00	20.00	
50	10.08	11.34	12.60	15.12	17.64	20.16	22.68	25.20	
60	12.16	13.68	15.20	18.24	21.28	24.32	27.36	30.40	
70	14.08	15.84	17.60	21.12	24.64	28.16	31.68	35.20	
80	16.16	18.18	20.20	24.24	28.28	32.32	36.36	40.40	
90	18.08	20.34	22.60	27.12	31.64	36.16	40.68	45.20	
100	20.16	22.68	25.20	30.24	35.28	40.32	45.36	50.50	
110	22.08	24.84	27.60	33.12	38.64	44.16	49.68	55.20	
120	24.16	27.18	30.20	36.24	42.28	48.32	54.36	60.40	
130	26.08	29.34	32.60	39.12	45.64	52.16	58.68	65.20	
140	28.00	32.50	35.00	42.00	49.00	56.00	63.00	70.00	
150	30.00	35.00	37.50	45.00	52.50	60.00	67.50	75.00	
160	32.00	37.50	40.00	48.00	56.00	64.00	72.00	80.00	
170	34.08	39.36	42.60	51.12	59.64	68.16	76.68	85.20	
180	36.32	40.36	45.40	54.48	63.56	72.64	81.72	90.80	
190	38.24	43.02	47.80	57.36	66.92	76.48	86.04	95.60	
200	40.32	45.36	50.40	60.48	70.56	80.64	90.72	100.80	
210	42.24	47.52	52.80	63.36	73.92	84.48	95.04	105.60	
220	44.32	49.86	55.40	66.48	77.56	88.64	99.72	110.80	
230	46.27	52.02	57.80	69.56	80.92	92.48	104.04	115.60	
240	48.32	54.36	60.40	72.48	84.56	96.64	109.72	120.80	
250	50.40	56.70	63.00	75.60	88.20	100.80	113.40	126.00	
260	52.48	59.04	65.60	78.72	91.84	104.96	118.08	131.20	
270	54.40	61.20	68.00	81.60	95.20	108.80	122.40	136.00	
280	56.48	63.54	70.60	84.72	98.84	112.96	127.08	141.20	
290	58.40	65.70	73.00	87.60	102.20	116.80	131.40	146.00	
300	60.64	68.22	75.80	90.96	106.12	121.28	136.44	151.60	
320	64.32	72.36	80.40	96.48	112.56	128.64	144.72	160.80	
340	68.48	77.04	85.60	102.72	119.84	136.96	154.08	171.20	
360	71.68	80.64	89.60	107.52	125.44	143.36	161.28	179.20	
380	78.08	87.84	97.60	117.12	136.64	156.28	175.68	195.20	
400	80.16	90.18	100.20	120.24	140.28	160.32	180.36	200.40	
420	84.64	95.22	105.80	126.96	148.12	169.28	190.44	211.60	
440	88.64	99.72	110.80	132.96	155.12	177.28	199.44	221.60	
460	92.61	104.22	115.80	138.96	161.92	185.28	208.44	231.60	
480	96.80	108.90	121.00	145.20	169.40	193.60	217.80	242.00	
500	100.80	113.40	126.00	151.20	176.40	201.60	226.80	252.00	
520	104.80	117.90	131.00	157.20	183.40	209.60	235.80	262.00	
540	108.96	122.58	136.20	163.44	190.68	217.92	245.16	272.40	
560	112.96	127.08	141.20	169.44	197.68	225.92	254.16	282.40	
580	116.96	131.58	146.20	175.74	204.68	233.92	263.16	292.40	
600	120.96	136.08	151.20	181.84	211.68	241.92	272.16	302.40	

RUNNING OVER 1900 STAMPS.

MEASUREMENT OF WATER

BY

DIFFERENT DITCH COMPANIES.

	Opening. Inches.	Pressure Board. Inches.	Mean Pressure. Inches.	Cubic Feet.
Amador Canal Co.....	2	4	5	1.40
Eureka Lake and Canal Co..	2	5	6	1.45
Park Canal and Mining Co.....	2	5	6	1.45
El Dorado Water and Deep Gravel Mining Co.	4	4	6	1.45
Mokelumne and Campo Seco Canal and Mining Co ..	4	3	5	1.40
Union Water Co., Murphys.....	4	4	6	1.45
South Yuba Canal Co.	4	4	6	1.45
North Bloomfield.....	2	6	7	1.60
Milton.....	2	6	7	1.60
La Grange.....	2	6	7	1.60
Smartsville Ditch Co.....	4	7	9	1.78

The North Bloomfield, Milton and La Grange companies measure through a 3-inch plank, the others use 1 and 1½-inch planks.

Parties using water from the Amador Canal Company, and the Mokelumne and Campo Seco Canal and Mining Company, will deduct 3½ per cent. from the Horse Power Tables on pages 28 and 29; and those using the water from the Smartsville Ditch Company will add 23 per cent. to the same table.

TABLE

Showing Friction of Water in Pipes.

Loss of head in feet for each 100 feet in different sizes iron pipes, discharging given quantities of water per minute.. $1\frac{1}{2}$ cubic feet = 1 inch.

S. W. KNIGHT.

DISCHARGING PER MINUTE.			SIZES OF PIPES—INSIDE DIAMETER									
Miner's Inches.	Cubic Feet.	Gallons.	1 in.	2 in.	3 in.	4 in.	5 in.	6 in.	7 in.	8 in.	9 in.	10 in.
.44	.66	5	2.00	.05								
.88	1.32	10	8.00	.24								
1.32	1.98	15	18.00	.56								
1.76	2.64	20	32.00	1.00								
2.20	3.30	25	50.00	1.56	.20							
2.64	3.96	30	72.00	2.24								
3.08	4.62	34		3.05	.40							
3.52	5.28	40		4.00	.52							
3.96	5.94	44		5.05	.66							
4.40	6.60	48		5.61	.81	.19						
6.60	9.90	74		14.05	1.84	.14						
8.80	13.20	98		25.00	3.28	.77		.09				
11.00	16.50	123		39.05	5.14	.40						
13.20	19.80	148		56.24	7.49	1.74		.22				
15.40	23.10	174		76.56	10.08	2.40	.78					
17.60	26.40	196			13.16	3.12	1.02	.40	.18			
22.00	33.00	247			20.56	4.88	1.67	.64		.15		
26.40	39.60	296			29.62	7.02	2.30	.92	.42	.21	.11	
30.80	46.20	345			40.32	9.56	3.13	1.25	.57	.29	.15	.09
35.20	52.80	395			52.62	12.49	4.09	1.64	.76	.38	.20	.12
39.60	59.40	444			66.33	15.81	5.18	2.08	.96	.48	.25	.15
44.00	66.00	494				19.52	6.40	2.56	1.18	.60	.31	.18
66.00	99.00	741					14.40	5.78	2.67	1.36	.71	.42
88.00	132.00	987					25.60	10.28	4.75	2.44	1.26	.75
110.00	165.00	1234						16.07	7.43	3.80	1.98	1.17
132.00	198.00	1481							10.70	5.48	2.85	1.68
154.00	231.00	1728								7.47	3.88	2.29
176.00	264.00	1975									5.07	3.00
198.00	297.00	2222										3.79

TABLE

Showing Friction of Water in Pipes.

Loss of head in feet for each 100 feet in different sizes iron pipes, discharging given quantities of water per minute. $1\frac{1}{2}$ cubic feet = 1 inch.

S. W. KNIGHT.

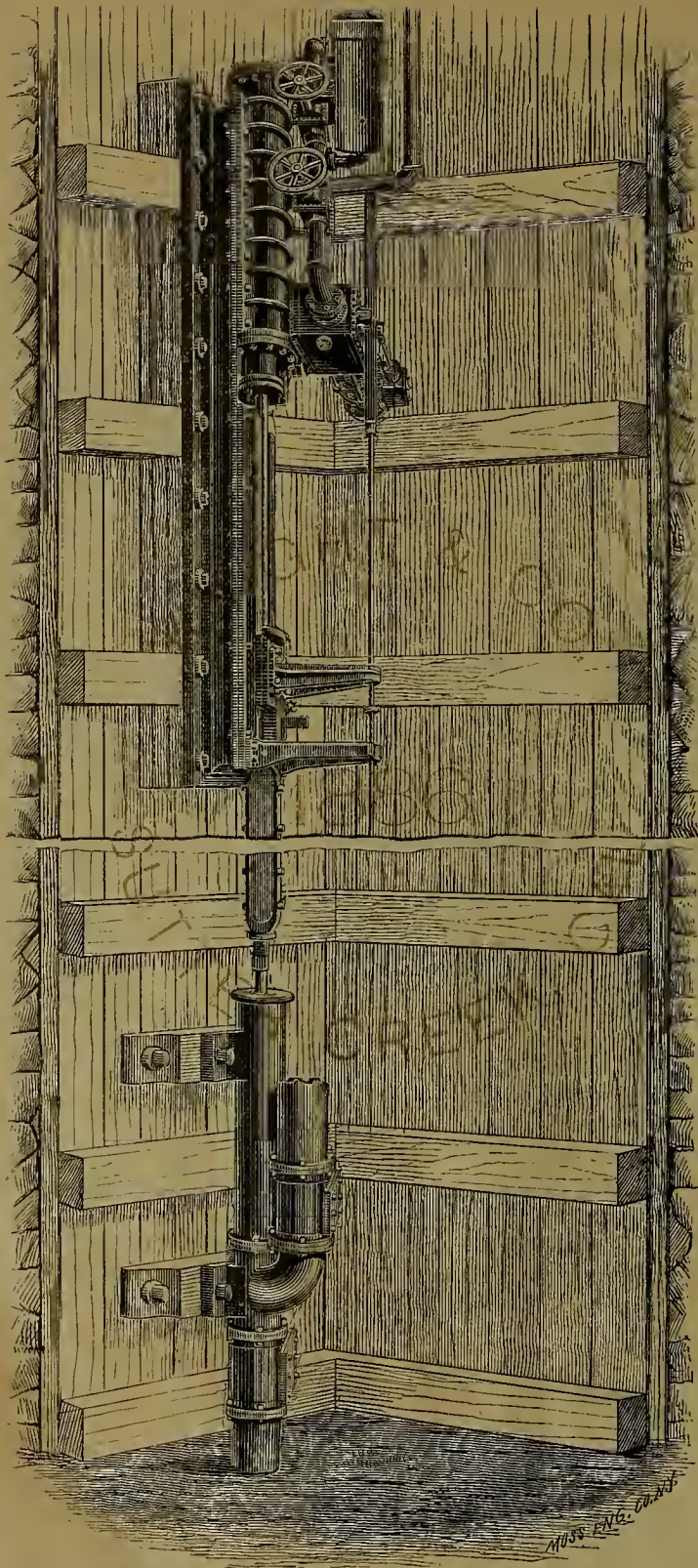
DISCHARGING PER MINUTE.			SIZES OF PIPES—INSIDE DIAMETER.										
Miner's Inches.	Cubic Feet.	Gallons.	11 in.	12 in.	13 in.	14 in.	15 in.	16 in.	18 in.	22 in.	26 in.	30 in.	37½ in.
66.00	99 00	740	.25	.16	.....	.....	.....	.....	.....	.....	.....	.....	.....
88.00	132 00	987	.46	.30	.19	.....	.....	.....	.....	.....	.....	.....	.....
110.00	165 00	1234	.72	.46	.31	.21	.....	.....	.....	.....	.....	.....	.....
132.00	198 00	1479	1 04	.67	.45	.30	.21	.....	.....	.....	.....	.....	.....
154.00	231 00	1728	1.42	.92	.61	.42	.30	.....	.....	.....	.....	.....	.....
176.00	264 00	1975	1 86	1.20	.80	.55	.40	.27	.....	.....	.....	.....	.....
198.00	297 00	2222	2.35	1.52	1.02	.70	.51	.....	.....	.....	.....	.....	.....
220.00	330 00	2468	2.91	1.88	1.26	.82	.63	.44	.24	.....	.....	.....	.....
264.00	396 00	2962	4.18	2.61	1.81	1.25	.88	.63	.42	.23	.....	.....	.....
308.00	462 00	3156	5.70	3.69	2.46	1.70	1.20	.87	.48	.28	.....	.....	.....
352.00	528 00	3549	.....	4.82	3.22	2.22	1.57	1.14	.63	.23	.09	.....	.....
396.00	594 00	4142	.....	.....	4.08	2.82	1.99	1.44	.80	.....	.....	.....	.....
440.00	660 00	4937	.....	.....	.....	3.48	2.46	1.78	1.09	.36	.15	.....	.....
484.00	726 00	5345	.....	.....	.....	.....	2.98	2.16	1.20	.....	.....	.....	.....
528.00	792 00	5924	.....	.....	.....	.....	3.55	2.57	1.42	.51	.21	.....	.....
572.00	858 00	6418	.....	.....	.....	.....	.....	3.01	1.67	.60	.....	.....	.....
616.00	924 00	6901	.....	.....	.....	.....	.....	3.50	1.94	.72	.30	.....	.....
704.00	1056 00	7899	.....	.....	.....	.....	.....	.....	2.53	.93	.....	.18	.....
792.00	1188 00	8784	.....	.....	.....	.....	.....	.....	3.21	1.17	.51	.....	.....
880.00	1320 00	9874	.....	.....	.....	.....	.....	.....	.....	1.45	.63	.31	.09
968.00	1452 00	10861	.....	.....	.....	.....	.....	.....	.....	1.76	.75	.....	.....
1056.00	1584 00	11848	.....	.....	.....	.....	.....	.....	.....	2.09	.90	.44	.14
1320.00	1980 00	14810	.....	.....	.....	.....	.....	.....	.....	.....	1.41	.69	.....
1760.00	2640 00	19747	.....	.....	.....	.....	.....	.....	.....	.....	2.52	1.23	.39
2640.00	3960 00	29585	.....	.....	.....	.....	.....	.....	.....	.....	.....	2.77	.90
3520.00	5280 00	39494	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.93	1.68
4400.00	6600 00	49368	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2.52

TABLE

Showing Thickness, Weight, Safe Internal Pressure, etc., of
Different Sizes of Sheet Iron Hydraulic Pipes.

S. W. KNIGHT.

Diameter of Pipes in Inches.	Area of Pipes in Square Inches.	Thickness of Iron by Birmingham Wire Gauge.	Pressure in Feet the Pipe will Stand.	Pressure in Pounds the Pipe will Stand.	Weight of Pipe per Lineal Foot in Pounds.	Thickness of Iron in Inches.	Price per Foot.
5	19	20	296	120	2.27	.035	
5	19	18	414	180	3.29	.049	
5	19	16	549	239	4.35	.065	
6	28	20	239	104	2.77	.035	
6	28	18	335	145	4.03	.049	
6	28	16	436	193	5.33	.065	
7	38	18	294	128	4.00	.049	
7	38	16	390	170	6.08	.065	
7	38	14	500	218	7.64	.083	
7	38	12	656	286	9.90	.109	
8 1/2	50	16	333	145	7.06	.065	
8 1/2	50	14	427	186	8.87	.083	
8 1/2	50	12	560	244	11.52	.109	
9 1/4	63	16	292	127	8.04	.065	
9 1/4	63	14	375	163	10.10	.083	
9 1/4	63	12	492	214	13.16	.109	
9 1/4	63	11	543	235	14.60	.12	
11	95	16	260	113	9.03	.065	
11	95	14	333	145	11.34	.083	
11	95	12	437	190	14.67	.109	
11	95	11	482	235	16.43	.12	
13	132	16	223	97	10.50	.065	
13	132	14	285	124	13.19	.083	
13	132	12	375	163	17.44	.109	
13	132	11	413	179	19.05	.12	
13	132	10	506	220	21.08	.134	
15	176	16	195	85	11.98	.065	
15	176	14	250	109	15.05	.083	
15	176	12	328	143	19.55	.109	
15	176	11	362	157	21.72	.12	
15	176	10	413	183	24.04	.134	
15	176	9	456	207	26.37	.149	
15	176	8	500	231	28.70	.164	
15	176	7	549	259	31.03	.179	
15	176	6	600	290	33.36	.194	
15	176	5	656	324	35.69	.209	
15	176	4	714	362	38.02	.224	
15	176	3	775	403	40.35	.239	
15	176	2	839	448	42.68	.254	
15	176	1	906	497	45.01	.269	
15	176	0	976	549	47.34	.284	
15	176	0	1049	604	49.67	.299	
15	176	0	1124	662	52.00	.314	
15	176	0	1201	723	54.33	.329	
15	176	0	1280	787	56.66	.344	
15	176	0	1361	854	59.00	.359	
15	176	0	1444	924	61.33	.374	
15	176	0	1529	997	63.66	.389	
15	176	0	1616	1074	66.00	.404	
15	176	0	1705	1154	68.33	.419	
15	176	0	1796	1237	70.66	.434	
15	176	0	1889	1323	73.00	.449	
15	176	0	1984	1412	75.33	.464	
15	176	0	2081	1504	77.66	.479	
15	176	0	2180	1600	80.00	.494	
15	176	0	2281	1699	82.33	.509	
15	176	0	2384	1801	84.66	.524	
15	176	0	2489	1907	87.00	.539	
15	176	0	2596	2017	89.33	.554	
15	176	0	2705	2131	91.66	.569	
15	176	0	2816	2249	94.00	.584	
15	176	0	2929	2371	96.33	.599	
15	176	0	3044	2497	98.66	.614	
15	176	0	3161	2627	101.00	.629	
15	176	0	3280	2761	103.33	.644	
15	176	0	3401	2900	105.66	.659	
15	176	0	3524	3044	108.00	.674	
15	176	0	3649	3193	110.33	.689	
15	176	0	3776	3347	112.66	.704	
15	176	0	3905	3507	115.00	.719	
15	176	0	4036	3672	117.33	.734	
15	176	0	4169	3843	119.66	.749	
15	176	0	4304	4019	122.00	.764	
15	176	0	4441	4201	124.33	.779	
15	176	0	4580	4388	126.66	.794	
15	176	0	4721	4581	129.00	.809	
15	176	0	4864	4780	131.33	.824	
15	176	0	5009	4985	133.66	.839	
15	176	0	5156	5197	136.00	.854	
15	176	0	5305	5415	138.33	.869	
15	176	0	5456	5640	140.66	.884	
15	176	0	5609	5872	143.00	.899	
15	176	0	5764	6111	145.33	.914	
15	176	0	5921	6357	147.66	.929	
15	176	0	6080	6610	150.00	.944	
15	176	0	6241	6871	152.33	.959	
15	176	0	6404	7139	154.66	.974	
15	176	0	6569	7415	157.00	.989	
15	176	0	6736	7699	159.33	1.004	
15	176	0	6905	8000	161.66	1.019	
15	176	0	7076	8309	164.00	1.034	
15	176	0	7249	8627	166.33	1.049	
15	176	0	7424	8954	168.66	1.064	
15	176	0	7601	9290	171.00	1.079	
15	176	0	7780	9635	173.33	1.094	
15	176	0	7961	10000	175.66	1.109	
15	176	0	8144	10375	178.00	1.124	
15	176	0	8329	10760	180.33	1.139	
15	176	0	8516	11155	182.66	1.154	
15	176	0	8705	11560	185.00	1.169	
15	176	0	8896	11975	187.33	1.184	
15	176	0	9089	12400	189.66	1.199	
15	176	0	9284	12835	192.00	1.214	
15	176	0	9481	13280	194.33	1.229	
15	176	0	9680	13735	196.66	1.244	
15	176	0	9881	14200	199.00	1.259	
15	176	0	10084	14675	201.33	1.274	
15	176	0	10289	15160	203.66	1.289	
15	176	0	10496	15655	206.00	1.304	
15	176	0	10705	16160	208.33	1.319	
15	176	0	10916	16675	210.66	1.334	
15	176	0	11129	17200	213.00	1.349	
15	176	0	11344	17735	215.33	1.364	
15	176	0	11561	18280	217.66	1.379	
15	176	0	11780	18835	220.00	1.394	
15	176	0	12001	19400	222.33	1.409	
15	176	0	12224	19975	224.66	1.424	
15	176	0	12449	20560	227.00	1.439	
15	176	0	12676	21155	229.33	1.454	
15	176	0	12905	21760	231.66	1.469	
15	176	0	13136	22375	234.00	1.484	
15	176	0	13369	22990	236.33	1.499	
15	176	0	13604	23615	238.66	1.514	
15	176	0	13841	24250	241.00	1.529	
15	176	0	14080	24895	243.33	1.544	
15	176	0	14321	25550	245.66	1.559	
15	176	0	14564	26215	248.00	1.574	
15	176	0	14809	26890	250.33	1.589	
15	176	0	15056	27575	252.66	1.604	
15	176	0	15305	28270	255.00	1.619	
15	176	0	15556	28975	257.33	1.634	
15	176	0	15809	29690	259.66	1.649	
15	176	0	16064	30415	262.00	1.664	
15	176	0	16321	31150	264.33	1.679	
15	176	0	16580	31895	266.66	1.694	
15	176	0	16841	32650	269.00	1.709	
15	176	0	17104	33415	271.33	1.724	
15	176	0	17369	34190	273.66	1.739	
15	176	0	17636	34975	276.00	1.754	
15	176	0	17905	35770	278.33	1.769	
15	176	0	18176	36575	280.66	1.784	
15	176	0	18449	37390	283.00	1.799	
15	176	0	18724	38215	285.33	1.814	
15	176	0	19001	39050	287.66	1.829	
15	176	0	19280	39895	290.00	1.844	
15	176	0	19561	40750	292.33	1.859	
15	176	0	19844	41615	294.66	1.874	
15	176	0	20129	42490	297.00	1.889	
15	176	0	20416	43375	299.33	1.904	
15	176	0	20705	44270	301.66	1.919	
15	176	0	21000	45175	304.00	1.934	
15	176	0	21300	46090	306.33	1.949	
15	176	0	21605	47015	308.66	1.964	
15	176	0	21916	47950	311.00	1.979	
15	176	0	22233	48895	313.33	1.994	
15	176	0	22556	49850	315.66	2.009	
15	176	0	22885	50815	318.00	2.024	
15	176	0	23220	51790	320.33	2.039	
15	176	0	23561	52775	322.66	2.054	
15	176	0	23908	53770	325.00	2.069	
15	176	0	24261	54775	327.33	2.084	
15	176	0	24620	55790	329.66	2.099	
15	176	0	24985	56815	332.00	2.114	
15	176	0	25356	57850	334.33	2.129	
15	176	0	25733	58895	336.66	2.144	
15	176	0	26116	59950	339.00	2.159	
15	176	0	26505	61015	341.33	2.174	
15	176	0	26900	62090	343.66	2.189	
15	176	0	27301	63175	346.00	2.204	
15	176	0	27708	64270	348.33	2.219	
15	176	0	28121	65375	350.66	2.234	
15	176	0	28540	66490	353.00	2.249	
15	176	0	28965	67615	355.33	2.264	
15	176	0	29396	68750	357.66	2.279	
15	176	0	29833	69895	360.00	2.	



KNIGHT HYDRAULIC PUMPING ENGINE.

The cut on the opposite page represents the Knight Hydraulic Pumping Engine. This is especially designed for pumping water out of mines to any depth where there is water pressure above the drain tunnel. This engine can be bolted to the shaft timbers at the drain tunnel, and a pump rod run down to a special plunger pump, made by Knight & Co., for use in connection with this engine.

By using this engine at the drain tunnel, the greatest amount of the useful effect of the water will be obtained. This method of pumping water out of a mine saves the enormous expense of gears, bob and foundation, and a long delay in setting up the ordinary pump, besides a great loss of power in the friction of heavy gearing and shafting. Both the engine and pump can be set on the same bed plate if desired, and the whole apparatus secured in the shaft below the surface or drain tunnel, and water to operate the engine carried down to it in suitable pipes. After operating the engine the water is exhausted into the discharge pipe of the pump. The only gain by doing this is in doing away with the pump rod. Nothing is gained in power. We make pumps that will pump 1000 feet high, or more if desired.

Often places are found in mining localities where there is a great amount of water from 50 to 100 feet below the mine. This can be utilized by Knight's Hydraulic Engine for pumping purposes, by using a large cylinder for the low pressures. This is connected with a small pump, and this in turn is connected by pipes to the pump in the mine, and operates it with perfect ease. Pressures corresponding to 700 to 1000 feet can readily be obtained, making the use of small pipes an advantage, thus saving great cost in the plant.

Our Hydraulic Engine will pump 30 per cent. more water out of a mine than any water wheel and gearing ever made. Parties having pumping to do in mines would do well to write for all particulars. In writing state the head of water from the ditch to the drain tunnel or whatever point the water is delivered from the mine; also the amount of water expected to be pumped; also depth of shaft.

All questions will be promptly answered, giving cost of construction, etc.

Patented March 31, 1885.

Reference is made to the letter from the Plumas Eureka Mining Company, on page 45 of this catalogue.

OUT OVER 6000 ACTUAL HORSE POWER.

The Facts in Regard to the So-called

GRASS VALLEY WATER WHEEL TEST.

The Idaho Mine, desiring to save as much water as possible, deemed it advisable to have a test of the relative merits of the different water wheels, and it therefore invited four or five different makers to compete. Among others accepting were Pelton and Knight.

There had been quite a delay in getting the water laid into the mine, and when the time came for the test, Mr. Coleman was very anxious to have it done as quickly as possible, so as to make no further delay.

Mr. Pelton put his wheel on the testing frame first, and ran it for half a day. The different conditions were noted, and rough estimates made of percentages, etc.

Mr. Knight put on his wheel next, and upon turning the water on, the nozzle burst. He, not having an extra one, was obliged to telegraph to Sutter Creek for another. This caused a delay of four or five days. Upon the arrival of the new one, a time was set for trial. Upon starting up again, Mr. Pelton and assistant did the timing and registering, and Mr. Knight was to look after the water. Mr. Knight noticed that the water was continually rising in the measuring box, and remarked that something was wrong. A few data had at this time been recorded. An investigation then followed, and a crack in the nozzle was discovered that rendered it impossible to proceed. It was evident that a further delay of five days would be required to duplicate the nozzle, and Mr. Knight knowing the anxiety of the Idaho Company to have no further delay, turned to Mr. Pelton and said: "I do not wish to keep the mine waiting any longer. I am satisfied from the performance of your wheel that mine could do no better, and I am willing to yield to you, providing you admit that my wheel has had no test, and no figures shall be published in regard to the whole matter."

Mr. Pelton assented to this, and Mr. Knight withdrew. This was on April 30, 1883. In the face of this, one month later, June 9, 1883, the whole affair was published, giving the Pelton wheel an astonishing record, and for the Knight, the data taken by Mr. Pelton and assistant under the conditions mentioned, with the water streaming out through the cracked nozzle. Mr. Knight had no part in making or revising the calculations, and was ignorant of the fact that they were being compiled for publication, inasmuch as it was contrary to agreement.

In support of the above statement we publish the following letter from Edward Coleman, Manager of the Idaho Mining Company, dated May 15, 1886:

EDWARD A. RIX,

San Francisco.

GRASS VALLEY, May 15, 1886.

DEAR SIR:—Your favor of May 13th came to hand yesterday, in reply will say, when we made the tests of water wheels in 1883, we used 116 inches of water, or 163.211 cubic feet per minute on the Pelton wheel, as well as on the other wheels with the exception of Knight's, and his nozzle broke so we could not measure the water which his nozzle called for.

Yours truly,

EDWARD COLEMAN.

In justice to ourselves, even at this late day, we cannot forbear to criticise the wonderful results obtained by the Pelton wheel, and we will say that although the tail race of the wheel frame was provided with a miner's inch measuring box, especially prepared, Mr. Pelton did not use it, and did all the measuring for his own test with his own hands, while the gentleman appointed to do this looked on. He made the measurements with a hook gauge, from which the results were registered in cubic feet. He used the same nozzle all the time, and by his gauge the greatest amount of water used was 162.9 cubic feet.

Mr. Knight and several others at the same time carefully measured the water in the miner's inch measuring box, and found it running 116 miner's inches. The preceding letter of Mr. Coleman verifies this measurement.

Mr. Pelton figured his percentage by his own record of cubic feet, and found 90.2 per cent.—an astonishing result, and one well calculated to make one doubt the accuracy of the measurements.

It is now a fact beyond all question that the Nevada County miner's inch is 1.45 cubic feet per minute, and consequently 162.9 cubic feet would be 112.35 inches; but by actual measurement he used 116 inches; therefore his gauge did not record cubic feet enough. By proportion we have $112.35 \times 90.2 \div 116 = 87.3$, which is his true percentage as far as water measurement is concerned.

The apparatus used for testing the wheels was good enough to test the comparative merits of the wheels, but when it came to determining accurately the percentage, it was not by any means accurate, for instance, the pressure on the brake was registered by a pair of platform scales and the beam was jumping and vibrating so much that it was impossible to register the pressure within quite a percentage. The timing also was not such as would pass muster on a fine calculation.

Taking all these things into consideration and also Mr. Pelton's interest in the matter, it is fair to assume that his wheel did not actually reach 87.3 per cent. but probably realized from 83 to 85 per cent., which is a splendid result, and one more consistent with the hydraulic data heretofore on record. A Pelton wheel tested at the University of California very carefully and scientifically showed a maximum percentage of 82.6 which bears out our preceding remarks.

At the Idaho test where the quantity was 116 inches, the head over 386.6 feet, and power about 100 horse power—conditions all favorable to the Pelton—the percentage obtained about 85 per cent., but at Ione where the Pelton wheel was put in under a head of 68 feet and quantity of water 400 inches, it did not realize 50 per cent. and was replaced by one of Knight's low head wheels.

Take the 120 stamp mill of the Alaska M. & M. Co. Here the same conditions exist as at the Idaho test, except that the power required is greater and yet thus far it has been a failure for the very reasons enumerated above. The head is 360 feet and power required about 250 H. P., number of revolutions required of the wheel is 236 to give the stamps 95 drops. There is a Knight and a Pelton on the same shaft each with complete and independent water connections. The Pelton has one nozzle.

Putting on the tip marked 375 cubic feet, the wheel makes 185 revolutions.

"	"	"	"	400	"	"	"	"	220	"
"	"	"	"	415	"	"	"	"	210	"

Showing that 400 cubic feet is all the buckets will stand and any increase of water will only be a detriment. The Knight wheel is running the mill easily at its proper speed, while the Pelton never has run it. At this time of writing Mr. Pelton has sent a double nozzle to take the place of the single one. This will of course enable his wheel to do the work, but with no high percentage.

It must be evident to anyone acquainted with water power machinery that the Pelton wheel can never be adapted to general purposes, where heads vary all the way from 10 to 700 feet and quantities from 10 to 1500 inches.

The Knight wheel however is above all a wheel for general work and will operate under all conditions by simply increasing or diminishing the length of the slit in the nozzle while the buckets remain the same. If small power is required move the slide in the slit so that the opening shall cover one or two buckets; if more power is required pull out the slide to cover more buckets until, as in especially low heads and large powers, the nozzle may extend completely around the wheel as shown on page 17.

The Pelton wheel cannot be governed without loss of percentage because any attempt to close off the flow of water while the size of the nozzle remains the same not only reduces the quantity of water but its pressure at the nozzle also. With the Knight wheel a perfect governing appliance is used as described on page 4.

Before purchasing water wheels parties should consider all of the above points and buy that wheel which will be to his advantage for his particular conditions of power, quantity and head and not from the results obtained by his neighbor, under totally different conditions.

The Pelton and Knight wheels may be seen working under precisely similar conditions at the Alta Pulp Mill, doing the same work and the superiority of the Knight is unquestioned although numerous changes have been made in the attempt to increase the efficiency of the Pelton. We respectfully call attention to the list of wheels at the end of this catalogue, as showing that they have come into general use throughout the coast.



MINING OPERATIONS AT THE ARROYO SECO MINE. [See page 42.]

LETTER FROM J. P. LAMBING,

SUPT. ARROYO SECO MINE.

TONE, April 5, 1886.

Messrs. KNIGHT & Co., SIRS:—

In reply to your letter asking how we are satisfied with your machinery, I have to say first in reference to your 15-inch Turbine water wheels, that they have given us perfect satisfaction. We were running one No. 6 and one No. 8 Vertical Centrifugal pumps with a 12-foot Pelton wheel under 68 feet head, with about 400 inches of water. We had to raise from 100 to 500 miner's inches 36 feet high, and the Pelton wheel required so much water and the pumps so much care that I was induced to substitute two of your 15-inch Turbines, and I cannot describe to you how perfect they work and how little care and attention they require, so easily regulated, no hot journals to watch, they run for weeks with no other attention than a little oil once in 12 or 24 hours. During the past 34 years I have used several of what were considered the best water wheels in use, among them the Pelton and Leffel Turbine, but for mining purposes I unhesitatingly recommend yours above all others that I have seen and having five of your wheels now in use I ought to be able to speak intelligently on the subject. Cheapness of first cost, durability, and made in one piece, not a complicated lot of pieces bolted together, to get loose and out of order. These are features in your wheels which ought to recommend them at once to practical miners. You can refer parties to me for any information relating to the above, but those wanting similar wheels and pumps should come here if possible and see them in operation.

Your centrifugal double discharge pumps also work to our entire satisfaction. The double discharge is a great improvement on the Eastern single discharge pumps, as it balances the driver so nicely and takes off all side friction and strain. I think the last pump and wheel sent me is the most perfect, cheap and economical pump now made. It will pump mud, sand, gravel, chips, leaves, or anything that will pass through a 3-inch square mesh.

We have pumped up with the water, sand and fine gravel as fast as two men could shovel it to the pump for hours at a time and raise it 36 feet high. No valves and packing to wear out and with the tappet and wheel bearing for the vertical shaft, it will not wear out in a life-time. We have had these pumps in constant use for the past two years and I cannot see that they are any the worse for the hard usage, although the ones we got from the East wore out in 5 months in doing the same work.

The steam derrick used in connection with the above wheels and pumps does its work as well as a derrick could do. We hoist from 5 to 7 tons at a load, on the end of a boom 110 feet long, hoist it 50 feet high, swing it out and dump it and return in 1½ minutes.

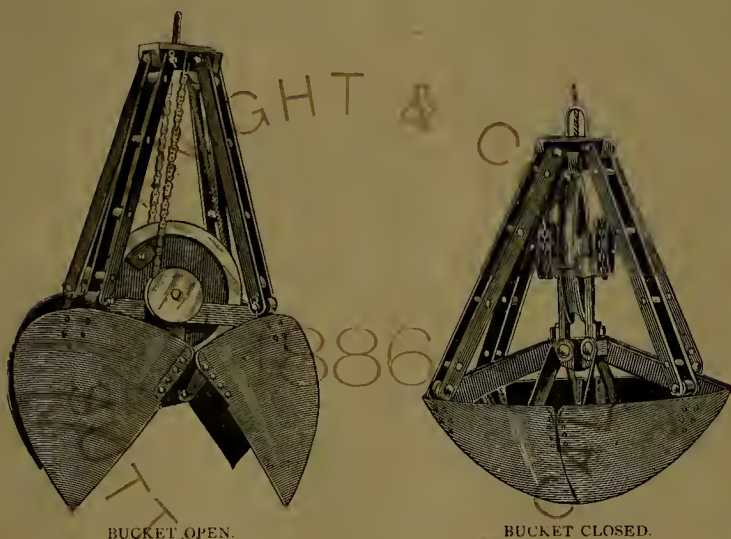
The boom is much easier handled and controlled than those built by the Lockport Derrick Builders who have the reputation of building the best, and it works in every way fully as well and in many respects better than those built in the Eastern States. This is the largest derrick on the Coast, I believe. I went East and examined derricks and ascertained prices before getting this one built, and persons thinking of building such should certainly examine this one in operation, before contracting for one. There is a large amount of mining ground throughout the Pacific Coast similar to our mine, where the stripping is too deep to admit of working by the old process but which can be profitably worked by using these powerful steam derricks to remove the strippings, and it is fortunate for mining interests that the best of derricks can be built here at the mines and at no greater cost than they can be had at the East. Having been engaged in mining for 34 years and taking a deep interest in the improvements and invention of new machinery, I am glad to see you so successful in meeting that want of the miner for which your long experience in the machinery business in the mines, so well qualifies you to do.

Sincerely yours,

J. P. LAMBING,

Superintendent Arroyo Seco Mine.

SELF DUMPING CRANE BUCKETS.



BUCKET OPEN.

BUCKET CLOSED.

This bucket is the one used at the Arroyo Seco Mine, on the end of the large boom described on page 42. They are self dumping and by far the most complete arrangement for handling earth, rocks or gravel in the manner described. Anyone desiring anything of the kind would do well to correspond with us on the subject, or with the Johnson Manufacturing Co., Duncan Building, 11 Pine St., New York.

KNIGHT'S CENTRIFUGAL PUMPS.

TABLE

Giving Sizes of Pulley and Discharge Pipes; also Capacity and Revolutions per Minute to Raise Water to Different Heights.

NUMBER OF PUMP.	Size of Discharge Pipes.	Capacity per Minute.	Diameter of Pulley.	Face of Pulley.	REVOLUTIONS PER MINUTE.						
	In.				Gallons.	In.	In.	5 Ft.	10 Ft. & 15 Ft.	20 Ft.	25 Ft.
3	3	400	8	6	494	580	650	711	775	830	890
3½	3½	600	10	6	496	582	645	705	762	815	872
4	4	900	10	8	487	567	600	650	700	760	800
5	5	1200	12	8	482	547	560	575	650	700	750
6	6	1800	14	10	440	495	470	500	600	670	700
7	7	2060	16	12	367	410	450	484	520	550	580
8	8	4600	18	14	300	333	367	390	414	440	460

	In.	Gallon.	In.	In.	40 Ft.	50 Ft.	60 Ft.	70 Ft.	80 Ft.	90 Ft.	100 Ft.
3	3	400	10	6	935	1024	1110	1190	1260	1325	1365
3½	3½	600	10	6	915	1000	1082	1155	1222	1307	1385
4	4	900	12	8	895	960	1000	1100	1175	1255	1300
5	5	1200	14	10	846	921	995	1058	1123	1183	1240
6	6	1800	16	12	750	810	871	927	980	1033	1085
7	7	2660	18	14	607	660	710	756	800	840	880
8	8	4600	20	16	485	525	575	609	643	663	695

PRICE LIST

Double Discharge Vertical Centrifugal Pumps

Including 8 feet of Shaft, two 28-inch diameter anti-friction Wheels, and steel face Tappet fitted to Pump Shaft and Boxes.

Number of Pump	3	3½	4	5	6	7	8
Price of Pump	\$165	\$175	\$200	\$220	\$230	\$250	\$300

We will fill Orders for all Sizes of Pumps.

Allow 50 per cent. more power than water to be pumped on large quantities, and on small quantities 75 per cent.

SAN FRANCISCO, CAL., April 1st, 1886.

Messrs. S. N. KNIGHT & Co.,

DEAR SIR:—The hydraulic pumping engine that you sent us, is working to our complete satisfaction. It is drawing two 12-inch Plunger pumps and raising the water 150 feet vertically. We use about 25 inches of water under a pressure of 700 feet to operate the engine. It is working along uninterruptedly and requires less attention than a steam or air pump, and we cannot say too much in its praise.

Any parties having pumping to do under similar conditions cannot do better than to put in one of your Hydraulic Pumping Engines.

Yours respectfully,

WM. JOHNS, Manager,
JOHN HOSKING, Sup't.,
J. A. PHIPPS, Engineer,
Plumas Eureka Mine.

1886

SUTTER CREEK, CAL.

KENNEDY MINE, JACKSON, AMADOR CO., CAL, April 13th, 1886.

S. N. KNIGHT, Esq.,

DEAR SIR:—The water power machinery with reversible wheels and adjustable nozzles, etc., built by you for the Kennedy Mine, works well and is giving good satisfaction and I can willingly recommend it.

Yours respectfully,

F. F. THOMAS,
Superintendent.

PARTIES USING KNIGHT'S WATER WHEELS.

Oneida Mining Co., Jackson, Cal.....	1
Con. Amador Mining Co., Sutter Creek, Cal.....	2
Lincoln Gold " " " " ".....	4
Mahoney Mining Co., Sutter Creek, Cal.....	3
Keystone Con. Mining Co., Amador City, Cal.....	4
Original Amador Mining Co., " " ".....	1
Gover Mining Co., Amador City, Cal.....	2
Gold Mountain Mining Co., Amador City, Cal.....	1
Gwin Mine, Mokelumne Hill, Cal.....	2
St. Patrick's Mill, New Castle, Cal.....	1
Julian Mine, " " ".....	1
Sheba Silver Mining Co., Nevada.....	1
Green Mountain Co., Plumas, Cal.....	2
Lucky Queen Mining Co., Oregon.....	1
Pittsburg and California Gold Mining Co., Smartsville, Cal.....	1
Republic Mill, Nevada Co., Cal.....	1
Sierra Buttes Mine, Sierra City, Cal.....	8
De Frees Mill, Tuscarora, Nevada.....	1
California Mining Co., Drytown, Cal.....	2
Plumas Eureka Mine, Plumas, Cal.....	9
Magalia Gold Mining Co., Magalia, Cal.....	4
Columbia Con. Gold and Silver Mining Co., Bull's Run Basin, Nevada.....	1
Mommoth Mills, Mammoth, Cal.....	1
Savercoal Mining Co., Prattsville, Cal.....	1
Alabama Mine, Jamestown, Cal.....	1
Pacific Mining Co., Placerville, Cal.....	2
Gopher " " " ".....	1
Talisman Gold Mining Co., Amador City, Cal.....	4
Mountain View Mining Co., Granite Hill, Cal.....	1
Blue Tent Mining Co., Nevada City, Cal.....	1
Spring Valley Mining Co., Cherokee, Cal.....	5
Banker Hill Mining Co., Amador City, Cal.....	5
F. M. Brown, Leadville, Colorado.....	2
Telurium Mining Co., Pine Grove, Cal.....	1
O. D. Barrett, Oakdale, Cal.....	1
R. P. & W. B. Clement, Oakdale, Cal.....	1
Mount Hope Mining Co., Grizzly Flat, Cal.....	1
Merrifield Mining Co., Nevada City, Cal.....	3
South Yuba Canal Co., You Bet, Cal.....	2
Farwell Mining Co., Leadville, Colorado.....	2
Lamphear Mining Co., Mokelumne Hill, Cal.....	3
Wells, Fargo & Co., Humboldt Bay, Cal.....	1
Help Bros., Ward, Nevada.....	1

Benfeldt Gravel Mine, Placerville, Cal.	1
El Dorado Water and D. G. Mining Co., Placerville, Cal.	2
Idaho Gold Mining Co., Gibbsonville, Idaho.	1
Big Bend Tunnel Co., Oroville, Cal.	1
Glencove Mining Co., Rail Road Flat, Cal.	1
Harmon Gold Mining Co., Auburn, Cal.	1
Zeile Mining Co.	1
Mammoth Mine, Jackson, Cal.	1
Byron Jennings, Nevada City, Cal.	2
Arroyo Seco Mine, Ione, Cal.	5
Grover Bros., Georgetown, Cal.	1
Jupiter Gold Mining Co., Altaville, Cal.	1
Monterichard Mining Co., Jackson, Cal.	1
Kelly Gold Mining Co., Jackson, Cal.	1
Matson " " " " " "	1
Moore " " " " " "	1
Panuco Silver " " Mexico	2
Navajo Mining Co., Tuscarora, Nevada.	1
Soulsby Mining Co., Sonora, Cal.	7
Oakdale Co. Planing Mill, Sonora, Cal.	1
Riverside Mine, Columbia, Cal.	1
Spring Gulch Mine, Tuolumne Co., Cal.	1
Patterson Mine, Tuttletown, Cal.	3
Arctic Manufacturing Co., Grizzly Flat, Cal.	1
Mount Pleasant Mining Co., Grizzly Flat, Cal.	1
Mowery Mills, Grizzly Flat, Cal.	1
Melton Mining Co., Grizzly Flat, Cal.	1
Belleville Mine, Belleville, Idaho.	1
P. J. Kelley, Saw Mill, Red Rock, Montana.	1
W. H. H. Bowers, Salt Lake, Utah	1
Pichias Mining Co., Durango, Mexico.	1
New Toleda Mill, Tuttletown, Cal.	1
Smartsville Flour Mill, Smartsville, Cal.	1
Granite Basin Mill, Plumas, Cal.	1
Loyal Lead Mine, Drytown, Cal.	1
New Almaden Quartz Mining Co., New Almaden, Cal.	2
J. Long, Moore's Flat, Cal.	1
Centennial Mine, Drytown, Cal.	1
Geo. Hagerman Mine, Drytown, Cal.	1
Amador Marble Works, Plymouth, Cal.	1
Fresno Enterprise Co., Fresno, Cal.	2
Melone's Con. Mining Co., Carson Hill, Cal.	1
Volcano G. G. Mining Co., Volcano, Cal.	1
Down's Mining Co., Volcano, Cal.	2
Pioneer Pulp Mill, Alta, Cal.	3
W. H. Porter, Angel's Camp, Cal.	1
Nashville Mine, Nashville, Cal.	4
Pleasant Valley Mining Co., El Dorado, Cal.	1

Springfield Mining Co., El Dorado, Cal.....	1
California Mining Co., Drytown, Cal.....	2
Alaska Mill and Mining Co., Douglas Island, Alaska.....	4
Butte Basin Mining Co., Jackson, Cal.....	2
H. A. W. Tabor, Jesus Maria, Chihuahua, Mexico.....	1
L. M. Mann, " " " ".....	1
A. M. Halter, Helena, Montana.....	1
Florence Gold Mining Co., Oroville, Cal.....	1
Shakspeare Mine, Forbestown, Cal.....	1
Amador Queen Mining Co., Jackson, Cal.....	5
Iowa Mining Co., Sutter Creek, Cal.....	1
Peter Fagan, Barley Mill, Sutter Creek, Cal.....	1
St. Julian Mine, Jackson, Cal.....	1
Russell Reduction Works, West Point, Cal.....	1
M. Murray, Lancha Plana, Amador, Cal.....	1
Campo Seco Copper Co., Campo Seco, Cal.....	2
Detroit Copper Co., Hawthorne, Nevada.....	1
G. G. Gilbert, Plymouth, Cal.....	1
G. G. Gilbert, Lamb's Bridge, Cal.....	1
Plymouth Con. Gold Mining Co., Plymouth, Cal.....	3
W. H. Armstrong, Douglas Island, Alaska.....	1
Morry & Sperry, New York.....	1
Oro Fino Mining Co., Shingle Springs, Cal.....	1
W. H. Russell, Belleville, Nevada.....	1
Monitor Mill and Mining Co., Steptoe Creek, Nevada.....	1
Utica Mining Co., Angel's Camp, Cal.....	1
What Cheer Mining Co., Mokelumne Hill, Cal.....	1
Crown Point Mining Co., Grass Valley, Cal.....	1
Wm. Robinson, Mokelumne Hill, Cal.....	1
Pyramid Mine, Shingle Springs, Cal.....	1
Columbo Mine, Sierra City, Cal.....	1
Manhattan Silver Mining Co., Battle Mountain, Nevada.....	1
Baker Divide Mine, Forest Hill, Cal.....	1
J. A. Edman, Saw Mill, Eagle Gulch, Cal.....	1
Kennedy Mining Co., Jackson, Cal.....	5
South Spring Hill Mining Co., Amador City, Cal.....	3
Golden Cliff Mine, Angel's Camp, Cal.....	1

OUT OVER 6000 ACTUAL HORSE POWER.

Blow Pipe Reagents

Supports

2 pe

Platinum Wire

Platinum foil

Platinum Forceps

Glass Tubes

closed Tubes & Glass Bulb Tubes

Agate Mortar

Hammer

Anvil

Pliers

File

Magnet

Lens

Watch-glasses

Test-tubes

Funnels

Porcelain Dishes

Wash-Bottle

Glass Rods

Filters

Accessories

Dry Reagents

Carbonate of Soda

Borax

Salt of Phosphorus

Nitrate of Cobalt

Nitrate of Potash

Bisulphate of Potash

Cyanide of Potassium

Iodide "

Sulphur

Tin

Zinc

Lead

Iron

Magnesium

Silver

Bone ash

Oxide of Copper

Oxalate of Nickel

Test Papers

Wet Reagents

HCl , H_2SO_4 , HNO_3 , P_2O_5 .

Ammonia (NH_4) HO

Carbonate of Ammonia (NH_4) CO_3

Chloride of Ammonium NH_4Cl

Phosphate of Soda $NaHPO_4$

Oxalate of Ammonia (NH_4) C_2O_4

Potassa K

Chloride of Barium $BaCl_2$

Nitrate of Silver

Molybdate of Ammonia







GWIN MINE DEVELOPMENT CO.

No 4 Sturtevant Blower should run

2225 rev. for 4 oz pressure with $1\frac{1}{10}$ H₂O

2470 " " 5 " " " $1\frac{2}{10}$ "

2690 " " 6 " " " $2\frac{1}{10}$ "

compiled from Sturtevant catalogue

C. H. Norton and Son, ~~Engl~~

